THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF GOOD LIGHTING

. OIL . GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by
J. STEWART DOW

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Special Features:

Colour and its Applications—The Jubilee of the Electric Lamp—Street Lighting in the United States—The Application of Electric Lamps to Advertising—The 19th Annual Exhibition of the Physical and Optical Societies—News from Abroad, etc.

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Colour and its Applications

THE paper read by Dr. L. C. Martin at the last meeting of the Illuminating Engineering Society on January 22nd dealt mainly with the scientific principles underlying the application of coloured light, and touched upon a number of outstanding problems which are still awaiting complete solution.

First and foremost amongst these is the question of colour nomenclature. Much able work has been done in this field, and some very comprehensive data have been collected, but it seems difficult to devise a universal system. Trades and industries concerned with coloured materials have methods of their own; in most cases it is difficult to specify a desired shade of colour with sufficient precision, and still more difficult to ensure that the prescription will be complied with. Some highly ingenious colour charts have been devised. An instance is the *Repertoire de Couleurs*, issued by the Société Française des Chrysthémistes, which contains a remarkable series of tints, each described in four languages. Another relatively new and fascinating method of reproducing and identifying colours is the "mutochrome" apparatus, demonstrated so effectively at the meeting by Mr. C. F. Smith.

But in the background there exists another and equally complex problem, the definition of what constitutes "white light." Dr. Martin describes an experimental standard based on the use of a standard filter with a carefully controlled electric lamp. This problem is of obvious moment in relation to systems of "artificial daylight," some of which have excellent colour-matching qualities, whilst others can only be regarded as very rough approximations to "average" daylight. It was encouraging to hear from Dr. Walsh that there is a good prospect of a specification for artificial daylight units becoming a practical proposition in the near future.

Dr. Martin also touched upon another interesting problem: the relation of colour to acuteness of vision. Something was said on this point in a paper read by Mr. J. S. Dow before the Society last year. It was then suggested that greater ease of accommodation might be one of the chief factors responsible for the "restfulness" commonly associated with forms of modified artificial daylight. But it is quite possible, as Dr. Martin infers, that the full explanation of the apparently better visual conditions has not yet been found. In passing, he draws attention to another factor which does not seem to have yet received sufficient attention—the relation of colour to speed of vision. This is of some importance, as it seems to suggest that the *quality* of light, apart from its intensity, may have an appreciable influence on the speed and efficiency of processes demanding quick action by the eye.

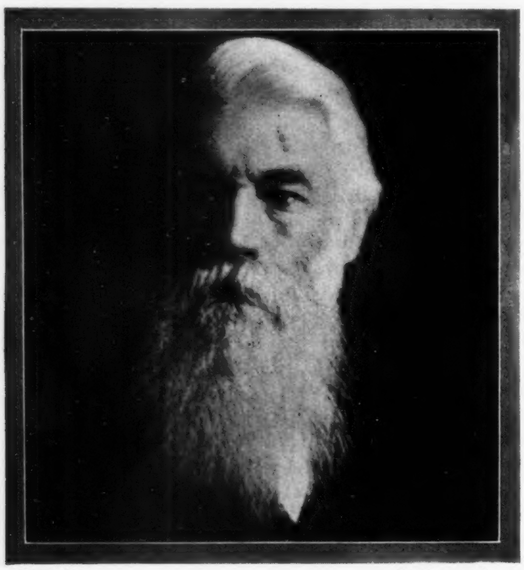
Our knowledge of all such phenomena has hitherto been limited by the fact that highly coloured light is necessarily expensive to produce in bulk. Coloured illumination, as used on the stage or in the kinema theatre to-day, is at present produced by subtractive methods, i.e., by the use of colour filters we absorb and waste a large proportion of the light available. When we recall that the process of light production is itself inefficient—even our most efficient illuminants do not convert into a luminous form more than about 5 to 10 per cent. of the energy furnished to them—we realize how much remains to be done. In the case of such sources as the neon lamp and the mercury vapour lamp we approach the desired goal of producing light in the region of the spectrum desired, and this only. Possibly, too, the stimulation by electric discharges of fluorescent materials may also afford a useful means of producing light of specified colour. But it is evident that for some time to come we shall depend mainly on subtractive, and therefore relatively wasteful, methods.

The illuminating engineer, therefore, when applying coloured light in bulk, is conscious that his efforts are necessarily "inefficient." But we do not mean to discourage the extending use of colour in illuminating engineering. "Efficiency," in the narrow sense, is not our only goal. Mr. D. R. Wilson, in his Presidential Address last year, made a striking reference to the important part played by colour, "the music of light," in our daily life. As a decorative medium, coloured light has vast possibilities. In the theatre it has long been an indispensable element, and it continues to play an ever-increasing rôle in scenic display. In the kinema theatre it has likewise great possibilities, and has already become a most valuable supplement to the display of films. The introduction of colour, not only in the film, but in the form of "colour-interludes" which afford relief to vision, is becoming quite usual. The "atmospheric" treatment of kinema theatres, which aims at using the decoration of the auditorium to supplement the action of the film, is in its infancy as yet. But here, too, the use of coloured light will probably play an important part in the future.

The Jubilee of the Electric Lamp

AN interesting item at the close of last year was the celebration of the birth of the electric lamp at the Institution of Electrical Engineers on December 20th. An admirable summary of the history of this invention was given by Mr. J. Swinburne, who was himself associated with much early pioneering work in this field. This lecture was supplemented by a comprehensive exhibit of electric lamps, including some historic examples illustrating the very earliest efforts of Sir Joseph Swan.

The idea of "subdividing the electric light" was conceived early in the last century, but it was only towards its close that the method of achieving this aim was discovered. The earliest mention of the incandescent lamp known to the lecturer was in the *Courier Belge* in 1836. This suggested the use of a carbon conductor electrically heated in vacuo as a solution of the problem of affording a suitable light in mines. We produce elsewhere in this issue (see p. 43) an early print depicting a demonstration of such a lamp by De Changy in 1850—surely a remarkable prophetic effort at this early date.



Photo] [Elliot & Fry.
The Late Sir Joseph Swan.
By the courtesy of "Electricity."

Many early workers attempted to use filaments of platinum and other metals of high melting point, and in 1845 J. W. Starr, an American, patented an apparatus employing metallic and carbon conductors in vacuo. But the production of a suitable filament was only part of the problem. Equally vital was the method of obtaining a high vacuum, and the invention of the Sprengel pump and the researches of Mr. (later Sir William) Crookes with evacuated glass vessels proved to be of outstanding importance. The interest of Joseph Swan was kindled by Starr's experiments. He began experimenting, and by 1855 he had succeeded in producing thin strips and spirals of carbonized paper—a novel invention at that time. The development of carbon "wires" followed. The fundamental process of heating this carbon wire by the passage of a current whilst the exhaustion of the bulb continued was devised in 1878. Swan developed the "parchmentized thread" obtained by treating cotton yarn, and in 1883 he invented the squirted nitro-cellulose process, and made other improvements. The first finished lamp, exhibited in 1878, aroused tremendous interest.

Meantime Edison had been working on parallel lines, originally with platinum filaments. In 1880 he patented the bamboo-fibre filament, and some of his lamps were exhibited in this country in that year. Eventually, as is well known, Edison and Swan joined hands, and their efforts paved the way for the electric lamp of to-day.

Mr. Swinburne left no doubt that Sir Joseph Swan was first in the field, but he remarked with truth that the priority of Sir Joseph in this invention should make no appreciable difference to the well-merited reputation, as a great inventor, of Edison, whose work has left its impress in so many different directions.

Street Lighting in the United States

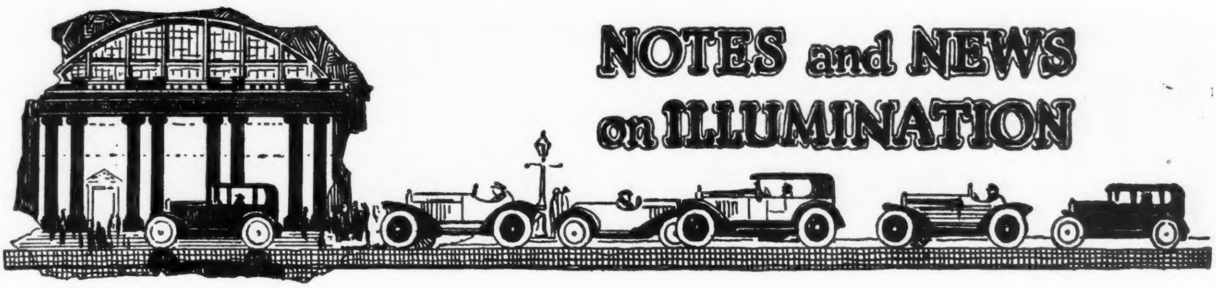
THROUGH the courtesy of Mr. J. F. Colquhoun, City Lighting Engineer, Sheffield, we have been favoured with a copy of the report he has drafted dealing with the International Illumination Congress in the United States. Whilst the report contains a general survey of the activities of the Congress—it is, indeed, one of the most comprehensive we have seen—Mr. Colquhoun naturally devotes his attention mainly to public lighting. His comparison of street lighting in the two countries is instructive. We gather that Boston and Lynn (Mass.) were considered better lighted than New York, and the lighting of Philadelphia is spoken of with special approval. Apparently the average expenditure on public lighting of American cities is rather more than 1 dollar (4s. 2d.) per head of population, but in some cities the figure exceeds 2 dollars. The latter is about three and a half times the corresponding figure for Sheffield (2s. 4½d.). The lighting of the now famous Washington Boulevard in Detroit naturally receives mention. This street is allotted no less than 92.6 watts per linear foot, as compared with 9.1 in Fargate, Sheffield, and 15.6 for the "Class B" installation in Prince of Wales's Road.

The cost of such spectacular lighting is often borne largely by local merchants—hence a natural tendency to attach weight to the *attractiveness* of the lighting system, a point which is sometimes neglected in this country. Ornamental diffusing lanterns and well-designed concrete standards are used with good effect. The new lighting of St. Louis, comprising 60,000 new lamps, is a big departure, on a scale most unusual with us. American cities have their own problems. In some cases the presence of elevated railways renders good street lighting difficult. On the other hand, the use of concrete-surfaced roads, with a high reflecting power, is often a distinct advantage.

Mr. Colquhoun describes in some detail the elaborate "model street" in use in the Edison Lighting Institute, which, though only 10 yards long, uses five miles of wiring and permits 282 different methods of lighting to be demonstrated. Such models are used for demonstration purposes in other laboratories. They serve to illustrate not only street-lighting effects, but also flood-lighting, the use of sky signs, etc. Readers of this journal will recall that something similar was described in Mr. Waldram's paper at Sheffield last year. Such models are useful for demonstrations, and have some value for experimental work, though naturally actual demonstrations in the streets—such as those afforded by the experimental roadway at Cleveland, and by the enterprising display at Sheffield last autumn—are best of all.

It is not surprising to learn that some difference of opinion was expressed by visitors from different countries in regard to methods of measurement, especially on the vexed point whether minimum or average illumination should be adopted.

Mr. Colquhoun comments on the excellent team work of the party of British delegates. He also confirms all that others have said regarding the wonderful kindness and hospitality shown to all the party, which we hope to have an opportunity of reciprocating in 1931.



Public Lighting in Liverpool

An informative report was recently issued by Mr. P. J. Robinson, the City Lighting Engineer for Liverpool, summarizing progress in the year ending March 31st, 1928. One of the chief features has been the extension in electric street lighting. The mileage of roads thus lighted has increased from 107 to 150—an increase of 43 miles, as compared with 23 for the previous three years. This is due partly to work on the housing estates at Norris Green, but also to improvements in the lighting of various main thoroughfares. An interesting experiment is being conducted in Townsend Avenue Continuation, where 12 projector lanterns, equipped with 500-watt lamps and mounted 220 yards apart, have been installed. So far experience with these lanterns, which are fitted with lenses and mirrors, has been encouraging. During 1927–28 the number of electric lamps in use increased from 6,325 to 8,555, whilst the number of gas lamps attained 26,337, as compared with 24,804 in the previous year. Renewals of electric lamps have fallen from 3.35 to 2.7 per lamp per annum. The number of mantles used per burner per annum, however, increased from 2.99 to 3.5, chiefly, it is stated, owing to the effect of the great gales experienced during the year. Certain lamp-posts are equipped both with gas and electric light, two one-light gas lamps, which are lighted throughout the night, having been added on each standard.

Lighting as an Aid to Health

A lecture on the above subject, under the auspices of the Jewish Health Organization, was given by Mr. J. S. Dow at the Whitechapel Art Gallery on December 22nd. Dr. H. A. Klisch, F.R.C.S., presided. In his opening remarks the lecturer recalled a series of articles contributed to *The Illuminating Engineer* by Dr. Moses Gaster, in which the important part played by light as an element in religions and in religious ceremonial was discussed. Darkness, he said, had always been associated with sickness and error, light with health and enlightenment. Instances of the beneficial effect of sunlight on health and of the use of natural and artificial light in the treatment of disease were given; but it was pointed out that both natural and artificial light must be used with discretion. The lecturer briefly traced the history of artificial lighting and illustrated its profound influence on civilization and human welfare. Abundance of artificial light had done much to assist the development of education and to render possible social intercourse in the evenings. It had played an important part in promoting the safety of the streets and assisting transport. Without artificial light the vast underground railway system of London could not continue. Dealing with the influence of light on safety, the lecturer recalled that there were nearly 140,000 accidents in the streets of London last year and nearly 250,000 reported accidents in factories. No doubt a considerable proportion of these mishaps could be traced to faulty lighting. Mr. Dow discussed simple problems of lighting in the home, in schools and in factories, and showed how, by the aid of the improved lighting equipment to-day, almost any problem in illumination could be solved. In conclusion, Mr. Dow referred to the great services rendered to illuminating engineering by the late Mr. Leon Gaster, and distributed amongst those present a number of copies of *The Illuminating Engineer* in which a summary of Mr. Gaster's activities had appeared.

Lighting Problems in Factories

One is always pleased to observe the publication of articles conveying sound principles of lighting in journals which appeal to those concerned with industrial and welfare problems. We notice in *Industrial Welfare* (December, 1928) three articles dealing with lighting problems in factories. The first of these summarizes some of the chief recommendations of the Home Office Departmental Committee on Lighting in Factories and Workshops, and alludes to the striking results obtained by the Illuminating Research Committee when studying the relation between illumination and the quality and output of work by compositors. This article is illustrated by numerous pictures of good and bad lighting, some of which originally appeared in *The Illuminating Engineer.* A second contribution, also illustrated, deals with factory lighting by gas. Some convenient modern types of fittings are illustrated, and the advantages of " distance control " in workshops are pointed out. The third article, entitled " Mobilizing Daylight," deals mainly with the use of special window glass which allows the ultra-violet rays to penetrate. The problem of obtaining a satisfactory type of glass which will (1) give maximum access to the desirable range of ultra-violet radiation, (2) will withstand exposure to sunlight without this permeance undergoing deterioration, and (3) will also not be too liable to scratching or corrosion is a somewhat complex one, though we believe that material progress in the direction of finding a glass which will unite all these characteristics has recently been made.

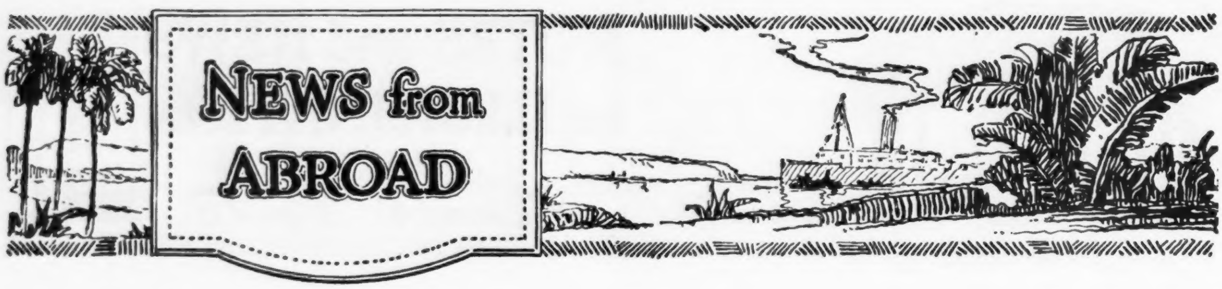
Mr. W. J. Jones, M.Sc. (Eng.), A.M.I.E.E.

APPOINTED MANAGER OF THE E.L.M.A. LIGHTING SERVICE BUREAU.

We are informed that Mr. W. J. Jones has been appointed Manager of the E.L.M.A. Lighting Service Bureau, in succession to Mr. W. E. Bush, who, as announced recently, has now taken up other work. Mr. Jones commenced his training in electrical engineering under Professor Sylvanus P. Thompson at the Finsbury Technical College, where he became senior student. On leaving the college he joined the staff of Messrs. Siemens Bros. & Co. Ltd., where he was associated first with the X-Ray Department, and subsequently with the electric-lamp department. After being for some time in charge of the works of A. C. Cossor Ltd., he joined the staff of the E.L.M.A. Lighting Service Bureau, of which he now becomes manager. As readers are aware, Mr. Jones has taken a keen interest in illuminating engineering, and is a member of the Council of the Illuminating Engineering Society. We wish him every success in his new position, where his technical knowledge of lighting problems should stand him in good stead.

Retirement of Mr. W. T. Layton

We note with interest the retirement of Mr. W. T. Layton, for twenty years Editor of the *Co-Partnership Journal.* In the January issue of the journal Dr. Charles Carpenter pays a tribute to his long and faithful service. The *Co-Partnership Journal* is naturally published primarily for the benefit of members of the staff of the South Metropolitan Gas Company. Its Editor wisely did not attempt to compete with contemporary journalism. But the publication under his charge has been edited by Mr. Layton in a very able manner, and frequently contains notes of general interest.



The Lighting of Test Charts

We recall that during the war the lighting of Snellen charts for testing acuteness of vision was the subject of study by a special committee formed by the Council of British Ophthalmologists, on which the late Mr. L. Gaster served. On that occasion the chief aim was to devise a simple arrangement of lamps, capable of general application, which would give adequate and sufficiently uniform illumination over the surface of the chart, and apparently the method ultimately adopted answered its purpose very well. One's attention is recalled to this problem by a very comprehensive series of experiments described by Messrs. R. S. Burnap and E. C. Jackson in a paper presented at the 22nd Annual Convention of the Illuminating Engineering Society (U.S.A.) last year. The most interesting item is the influence of high illuminations on acuteness of vision thus tested. A range of illumination up to 1,500 foot-candles was used. Up to 75 foot-candles a notable improvement in acuteness of vision was observed, and apparently some improvement still occurred at higher levels. A change in illumination from 2 to 100 foot-candles led to a change of *one line* of reading ability! The authors recommend 100 to 125 foot-candles for ordinary test work, as at this level the eye appears to be approaching saturation, and it is sufficiently high to prevent the conditions of general lighting in ordinary rooms having any material influence. Other points of importance are the avoidance of any possible glare from extraneous exposed lights, etc., and the choice of the scheme of decoration for the room, so as to furnish a suitable background. It is somewhat surprising, in view of the results of earlier observers, that these high illuminations should be found necessary to obtain maximum acuteness of vision in such a simple process as the observation of bold type on a white background. Possibly, however, the high brightness of the white background has the effect of stopping down the eye-lens and thus improving the acuteness of some eyes.

A Course in Illuminating Engineering in Germany

One of the most keenly debated subjects at the International Illumination Congress was the procedure in regard to education in illuminating engineering. It is evident that in Germany the Illuminating Engineering Society is taking an active part in the solution of this problem. A series of weekly lectures by experts, supplemented by demonstrations and laboratory work, has been arranged to take place at the Technische Hochschule in Berlin, Charlottenbourg, during the period January-March, 1929. The course is stated to be organized by the Society with the co-operation of the Technische Hochschule and the *Elektrotechnisches Verein.* The course covers a wide ground, but is apparently confined to electric lighting. Dr. Wedding, Herr L. Schneider, Dr. M. Pirani, Dr. L. Bloch, and other well-known experts, are responsible for lectures. The first three evenings are devoted to fundamental principles and photometry, after which electric illuminants and their applications are to be dealt with and such subjects as the lighting of factories, offices, shops and streets discussed. A small charge is made for the course, a specially low rate being granted to students and members of the Society.

The Behaviour of Internally Frosted Lamps

Although the advantages of the internally frosted lamp are now generally familiar, a note in a recent issue of *l'Electricien*, which deals lucidly with their characteristic properties, is worth attention. As is well known, the absorption of light by such bulbs is much less than in the case of bulbs subjected to external frosting—indeed, the loss of light is said to be as little as 1.5 per cent. The chief explanation offered for this is that when the glass is internally frosted the rays from the filament in general only traverse the glass once, whereas with externally frosted lamps they undergo successive internal reflection. An additional factor responsible for absorption is the tendency of dust to deposit on the rough exterior of an externally frosted lamp, a source of depreciation which becomes continually greater, and therefore tends to shorten the useful life. The introduction of this type of lamp and its increasing use amongst consumers has done much to diminish glare. At the same time, we do not think that internal frosting is quite so effective as some other methods; for example, the external " white spraying " which preceded it, or the construction of bulbs of opal glass which appear uniformly bright all over. The chief drawback of the internally frosted lamp is that, whilst the light from the filament is materially softened, it is not distributed uniformly over the bulb. One still sees a central patch of light of relatively high intrinsic brilliancy. If the method of internal frosting could be so modified as to yield a bulb of uniform brightness this would render the lamps still more serviceable.

The Effect of Dark Surroundings upon Vision

A recent contribution to the *Journal* of the Franklin Institute, by Dr. Percy W. Cobb and Mr. F. K. Moss, draws attention to the fact that the surrounding of a bright field by a much darker background may result in an appreciable diminution in visual acuity. Every student of illumination is aware that the sense of vision is at a great disadvantage when trying to discern dimly lit objects in the middle of a brightly lit field—for example when one tries to observe objects in a dark cave or tunnel whilst standing in bright sunlight. But the influence of the surrounding area in converse conditions, e.g., when looking at a brightly lighted street through the window of a dark room, is less generally recognized. Experience has shown that the best results are obtained when the surrounding area is of about the same brightness as the central field of observation—a point of interest in photometry, and also of moment in the design of kinema theatres. The research now described involved a test of the accuracy with which one stylus could be kept in opposition with another, moving slowly and irregularly, both being seen in silhouette on a small bright field. As a result of nearly 400,000 measurements it was found that the precision was greatest with the largest extent of bright surroundings, though the difference was perceptible chiefly as the border was pushed outward from 8° to 16° from the visual line. The extreme difference in precision was 4.3 to 7.7 per cent. The importance of such a change in practice would naturally depend on the extent to which failures to see outnumber successes.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Colour and its Applications

(Proceedings at the meeting of the Illuminating Engineering Society held at the Home Office Industrial Museum, Horseferry Road, Westminster, at 6-30 p.m., on Tuesday, January 22nd, 1929.)

A MEETING of the Illuminating Engineering Society was held at the Home Office Industrial Museum (Horseferry Road, Westminster, S.W.1), at 6-30 p.m. on Tuesday, January 22nd.

Members assembled at 6-30 p.m., when light refreshments were provided, and any visitors who had not already done so had an opportunity of examining the lighting section of the museum.

The chair was taken by the PRESIDENT (Mr. C. C. Paterson) at 7 p.m. After the minutes of the last meeting had been taken as read, the Hon. Secretary read out the names of applicants for membership, which were as follows:—

Ordinary Members—

Baker, C. H. ............H.M. Office of Works, Engineering Division, Westminster, S.W.1.

Imrie-Smith, W. ....Scottish Electric Lighting Service Bureau, 20, Trongate, Glasgow.

Oughton, E. L. ....Gas Sales Superintendent, South Suburban Gas Co., Lower Sydenham, London, S.E.

Associates—

Winsor, A. G. ....Lighting Inspector to the Southern Railway, Woking.

Country Members—

Barrett, W. ................H.M. Inspector of Factories, 73, Sedgley Avenue, Rochdale.

Elliott, W. J. ....99, Gladstone Street, Portsmouth.

Sustaining Members—

Messrs. Falk, Stadelmann & Co. Ltd., Farringdon Street, London, E.C. (*Representative*—Mr. E. W. Stockwell.)

Messrs. The London Electric Firm Ltd., Brighton Road, South Croydon. (*Representative*—Mr. G. A. Hughes.)

The HON. SECRETARY then read out again the names of applicants presented at the last meeting,* and these gentlemen were formally declared members of the Society. He remarked that a steady addition was being made to the membership month by month, but they all hoped before long to be able to record a more substantial increase, and members should do all they could to interest others in the work of the Society and induce them to join.

The PRESIDENT then called upon Dr. L. C. MARTIN to deliver his paper, entitled **"Colour and Its Applications."** (See pp. 34–39.) In the earlier part of the paper Dr. Martin touched upon the phenomena underlying colour harmony, and discussed the influence of colour on acuteness of vision. Some curves bearing on speed of vision were presented, and various effects, such as colour contrast and visual induction, were illustrated. Later, Dr. Martin dealt with colour measurement, and described some recent work done by Mr. W. D. Wright at the Imperial College in this field. He explained a method of obtaining experimentally a "standard white," and discussed methods of checking the colour temperature. The concluding portion of the paper dealt with such matters as colorimetry and colour nomenclature. Reference was also made to various practical applications of coloured light, such as the use of "artificial daylight" for colour-matching purposes and its influence on the eye.

The paper was illustrated by a number of attractive experiments, and a demonstration of the "mutochrome" apparatus by Mr. C. F. Smith, in the course of which colour mixture and other phenomena were exhibited in a very clear and effective manner.

The PRESIDENT, in opening the discussion, remarked that all present would join him in welcoming Mr. A. P. Trotter, whom they all regarded as the "father of illuminating engineering," and who had presided at many meetings of the Society in the past. The President's remarks were greeted with acclamation, and at his request Mr. A. P. TROTTER opened the discussion. Amongst others who took part were Mr. W. D. WRIGHT, Mr. R. G. WILLIAMS, Dr. J. W. T. WALSH, Mr. B. P. DUDDING, Mr. L. G. APPLEBEE, Dr. S. ENGLISH, Mr. T. E. RITCHIE, Mr. L. E. BUCKELL, Dr. G. FRANCIS NEW and Mr. J. A. MACKENTIRE. A feature of Mr. Applebee's contribution was a striking demonstration of the remarkable changes in the appearance of coloured landscapes and designs when illuminated respectively by red and green light. Written communications from Dr. R. A. HOUSTON (Glasgow University) and Dr. S. G. M. BARKER (Research Director to the British Research Association for the Woollen and Worsted Industries) were also presented.

After Dr. Martin had briefly replied to some of the points raised in the discussion, a cordial vote of thanks to him for his paper was passed unanimously, and likewise to Mr. C. F. Smith, whose demonstrations had added so greatly to the interest of the meeting.

In conclusion, the PRESIDENT announced that the **next meeting** would be held at the Industrial Museum, on February 19th, when there would be an informal discussion on **"Problems in Illuminating Engineering."**

He also called attention to the **Twentieth Anniversary Dinner** of the Society, to be held on **February 13th,** when it was hoped that all members would make a special effort to attend.

* *The Illuminating Engineer*, January, 1929, p. 5.

Colour and its Applications

By L. C. MARTIN, D.Sc., A.R.C.S.

(Assistant-Professor, Dept. of Technical Optics, Imperial College of Science and Technology)

(Paper presented at the Meeting of the Illuminating Engineering Society held in the Lecture Theatre of the Home Office Industrial Museum (Horseferry Road, Westminster), at 6-30 p.m., on Tuesday, January 22nd, 1929.)

THE title of this lecture probably conveys very different ideas to various minds. The painter thinks of pigments used in pictures and decoration; the physicist thinks of the frequency of vibration of radiation; the physiologist thinks of electrical nerve currents; the psychologist of mental experience. Such a title, then, can impose no limitations on the treatment of the subject.

The members of the Illuminating Engineering Society have had in the recent past a good many papers and lectures bearing on this subject or special aspects of it, and it would be difficult to set out to compose an essay which would be of an entirely novel character. My aim will be rather to make a brief survey of some aspects of the scientific study of the subject of colour in its present state, and to emphasize such points as appear to be of most importance to the illuminating engineer.

Colour is a matter of experience; without the person who sees and understands there can be no colour sensation—no "light," no "sound." The physical world, as projected by our senses and in our thought, is an experience which depends to a tremendous extent on the conditions of observation; if one could imagine a demon small in comparison with the dimensions of an atom his experience of the physical universe would doubtless be very different from our own. The emotional and æsthetic effects of sensation vary so very much with experience and training, and the sensation of colour is no exception.*

Colour Harmony.

May we mention briefly the controversial subject of "colour harmony"? Numerous efforts have been made to discover a physical basis for the common experience that there are colours which "go well" together, and cause pleasure in juxtaposition. The physical basis of musical harmony, the simple relations in the frequencies of harmonizing notes which preclude unpleasant and jarring effects of "beats" between the notes themselves and their prominent overtones, seems quite likely to be as much a negative as a positive effect. Certain it is that, as Sir Walford Davies has been teaching us, the sense and enjoyment of musical harmony has developed down the times of musical history. The emotional effect is vastly enhanced by rich experience.

We may dismiss at once the idea that there is a physical basis of an analogous character in the frequencies of the vibrations constituting the colour-sensation-producing stimuli. To begin with, the experience of discrete colour stimuli results in their separate appreciation. In music the sensation of a particular harmony is unique, although the elements may be recognized through experience. The result of *adding* two colour stimuli is that the identity of the two is, in general, entirely lost in the mixture.

There are, however, physiological phenomena which may perhaps throw some light on the question, namely, those of simultaneous and successive contrast; the phenomena which the physiologists term "induction." These have already received a considerable amount of study, but when all this is done and when a few of the more readily appreciated colour harmonies have been listed, as for example by Miskells,† it will have to be admitted that the factors of association and experience are of paramount importance. Writing on "colour preferences" in 1922, I said: "Cohn's tests indicated the choice between saturated and unsaturated colours, and decisive evidence points to the preference of the fully saturated specimens. Is there a connection here between the indifference to yellow, the "nearest" colour to white, and the less-saturated colours? These preferences will lead to interesting speculations as to their origin. Do we not prefer the fugitive and bright colours of the flowers to the more lasting green of the leaves? Is not red the colour of animal life, of the warmth-giving fire, and the hot blood which rises in anger; is not blue the colour of peaceful sky and sea, and the colour of many flowers? . . . . A wider topic, and one of engrossing interest to the decorative artist is that of preference in colour contrasts. . . . Contrasts which would not be used in dress, dark green and pink for example, may be considered very beautiful in a flower garden."

The illuminating engineer may in these days have to be an artist who paints in light. When he has learned a few simple ideas regarding harmony, i.e., the generally acceptable contrasts between complementary colours, the use together of colours not differing greatly in hue, and the usual harmonizing effect obtained by desaturating "clashing" colours he can make a certain amount of progress, but all the above is to be taken as a warning that there are no easy rule-of-thumb methods to be obtained out of colour theory. The success of the artist in light will ultimately depend on his own æsthetic capacity as well as his "control of his medium."

Requirements of Human Vision.

"Control of the medium" means a great deal in the purely utilitarian aspects of illumination. I think the late Mr. Leon Gaster once traced the progress of illumination technique as "Light; more light; enough light." I ventured to add "enough light of the right quality." We are thus dependent on our knowledge of the eye and receiving apparatus generally to indicate what are the quantities and qualities of radiation required, and then on our various methods of producing it. Shall we then take a rapid glance at some results of the study of vision, and at some methods of photometric and colorimetric measurement, to see how they may affect illumination requirements?

The power of radiant energy to stimulate the sensation of light, and in particular that attribute of light we call brightness, has been frequently measured. The well-known "visibility curve" for normal vision expresses the relative brightness per unit energy at various wavelengths. The average "visibility" curve averaging the results of 250 observers, as obtained by Gibson and Tyndall, of the Bureau of Standards, is so well known that it need not be reproduced here. (See Bureau of Standards Scientific Papers, No. 475, 1923.)

In the light of this result it is *more easy* to understand the remarkable fact that the visual acuity of the eye with its non-achromatic optical system is only improved about 10 per cent. by substituting monochromatic for white light, as shown by the experiments of Luckiesh and others. Nevertheless the "geometric disc of confusion" corresponding to a star image on the retina, formed with white light, corresponds to a diameter of 0.04 mm. with a 4-mm. pupil, which is about twenty times the diameter of a cone. When it is remembered that the acuity, as expressed by the "minimum separabile," corresponds to twice the cone diameter, or, expressed in terms of the "contour acuity" (of which we make use in coincidence range-finders), corresponds to a small fraction of the cone diameter, it becomes obvious that the explanations and theories so far advanced are hardly adequate, even when allowance is made for the divergences between physical and geometrical accounts of image formation.

The above has a certain bearing on the question of relative comfort of vision in "artificial daylight," as compared with ordinary artificial light. From the physical standpoint it seems that the relative absence of the shorter wavelengths in the ordinary artificial light might conduce to a greater relative physical concentration of the image, but the difference on this account can, in view of Luckiesh's work, only be a small one. It may

* Taylor, "Colour Sense Training," Blackie & Son.

† Miskells, "Practical Colour Simplified," Chicago, 1928.

be that the factors which produce high acuity are concerned with delicate reflex and inhibitory effects in the interconnecting nerve cells of the retina, but we have not at present any adequate data which can be used to give a definite answer to such problems, and we are limited to direct experiments which, from the nature of the problem, are difficult to make reliable. Priest* has reported some observations which afford some evidence that artificial daylight gives greater comfort than the light of a gasfilled tungsten lamp, but further work is still required. An illumination of 8 to 10 foot-candles of artificial daylight gave satisfaction, but 3 to 4 foot-candles were deemed inadequate.

Another suggestion has been made, that as the "centre of gravity of the radiation" forming the image would be at a shorter wavelength with artificial daylight than with ordinary artificial light, the effort of accommodation would be less with the former illuminant. Here again the small magnitude of the difference makes it difficult to come to any conclusions. I think it quite likely, as I hint above, that the full explanation of the acuity of ordinary vision has still to be given.

Speed of Vision.

It is well known that visual acuity is low at low illuminations, and only increases slightly when the illumination is increased beyond an "adequate" level, but it is not so well realized that the rate of growth of the visual impression varies with the intensity of stimulation. Fig. 1 represents some results obtained many

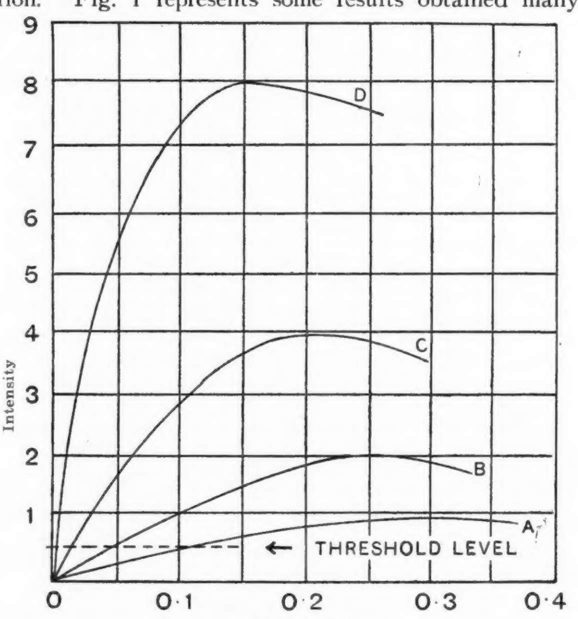


Fig. 1.—Exner's Results showing the Rise of Sensation with Time.

Relative Intensities of Stimuli: A .... 1; B .... 2; C .... 4; D 8

years ago by Exner, and shows how a strong stimulus produces a response which attains both its threshold level and maximum more quickly.

Illumination which may be adequate for observation of steady objects fails when quick vision is required. If one tries to play the piano while "reading" music in deepening twilight the speed of reading is necessarily slackened even while the individual "notes" of the music can easily be seen. In observing an object moving across the visual field of an eye, its apparent positional direction always lags behind its actual position; the more so if the illumination is small. The stereoscopic sense of relative distance or position depends on the response of the two eyes. Therefore, if the response of one eye is delayed, say, by the use of a dark glass in the path of the light, the lag is correspondingly greater for that one.

Hence, as indicated by Fig. 2, an object moving to and fro in the same straight line may appear to have a circular or elliptical motion in the plane of vision, a motion which is, of course, only apparent to the stereoscopic sense. Both eyes, L and R, see the object O "behind its actual position," but L more so than R. The apparent position in space is at the crossing of the lines of apparent direction from each eye.

Pulfrich's interesting suggestion of making this the foundation of a method of heterochromatic photometry

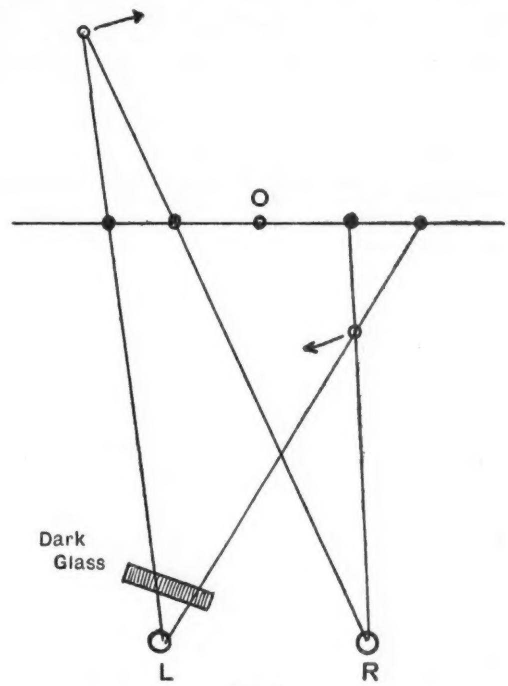


Fig. 2.

has proved too fanciful. While the relative rate of growth of the visual impression is roughly a function of the *brightness*, there is evidence that it is also a function of the nature of the light. Beside this, the stereoscopic sense is not usually sufficiently well developed in many observers to render this a safe experimental method.

Stereoscopic Effects of Colour Contrast.

While speaking of stereoscopic effects, I am always intrigued by the natural stereoscopic effects of contrasting monochromatic colours, which arise through the non-coincidence of the visual and optical axis directions of the eyes. They are most marked in theatrical productions, as when one side of a man's face is illuminated by a red spotlight, the other by a blue. The effect is weird, but as the majority of persons seem to have a habit of inhibiting any effect which "ought not to be there," it is not often commented upon. Red and blue letters on one black ground often seem to be at relatively different heights.

Visual Induction.

"Spatial induction" was mentioned above. By this is meant the influence of the stimulation of one region of the retina exerted upon the vision of another region. The effects of colour contrast are well known, and are described in all the ordinary text-books, so that they need not be detailed here. They ought, however, to be better known than they are, especially to those who produce decorative effects in colour. I wish to refer now only to recent experiments on the effects of spatial induction on contrast sensitivity. Fig. 3 shows some results obtained by Emerson and myself a year or two ago on the percentage limen of perceptible contrast for the centre of the visual field (the eye was fixed on a 2° × 3° tripartite field surrounded by a 20°-field of variable intensity).

Experiment showed that a lower limen of contrast could always be obtained by surrounding the central matching field by a wider field of low intensity. As the brightness of the surround increases the central limen

* Priest, *Jour. Opt. Soc. America*, 15 (1927), 131.

falls to a minimum, thereafter rising above the normal value, but when a blue field is employed the surround brightness may be increased to as much as three times the central brightness before a decrease in the limen, as compared with that for a dark surround, sets in.

Whatever be the explanation of these effects, they are important from the practical point of view in several ways. They re-emphasize the folly of trying to do work involving sensitive visual discrimination of contrast with a small central part of the field of vision bright, amid darker surroundings. They suggest that the best effects in a picture theatre would be obtained by a preponderance of blue in the surroundings of the screen, rather than the warmer colours, which, of course, are more "comfortable" in their suggestive effects.

We might note in passing that the drapers' shops made a great mistake at one time in trying to illuminate whole showrooms by "artificial daylight." One only needs it in a few limited regions, but it ought to be available when required. Such was the reaction from the imaginary "coldness" of the daylight lamps that the unfortunate shopper is now again usually in the condition of being practically unable to see what he is buying.

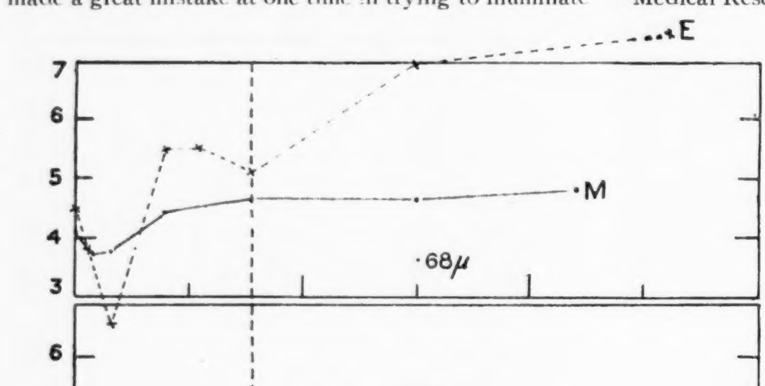


FIG. 3.

The provision of a surround to stimulate the central parts of the retina is found to make practically no difference to the *acuity* of form vision, either monocular or binocular.

Of course, the surround intensities referred to in the foregoing paragraphs are well below the limit at which the effects of glare would commence.

The provision of a surround of suitable intensity offers one means of increasing the precision of photometric matches, but of course involves certain instrumental difficulties which will probably prevent the device from being generally used.

COLOUR MEASUREMENT.

The phenomena of colour mixture and modern studies of colour vision and colour measurement are not perhaps topics which interest the illuminating engineer a great deal, except in so far as a grasp of the actual facts of colour vision is important for the understanding of the essential requirements in providing illumination which permits of the satisfactory vision of colour.

May I say a few words, however, on some recent work which has been in progress at the Technical Optics Department of the Imperial College. Mr. W. D. Wright, a research student holding a scholarship from the Medical Research Council, has designed and constructed a very ingenious colorimeter, which is illustrated in Fig. 4.

The slit S is illuminated by a beam from a pointolite lamp, and the light is collimated by the lens C. A parallel beam now passes *over the top of prism D* to the two dispersing prisms A, A; a part of the light so dispersed passes *over* the next right-angled prism and is focussed into a spectrum by the lens T_1, while a second part is reflected by the right-angled prism and focussed into another spectrum by the lens T_2.

Small "roof" reflectors can be placed in each spectrum; the diagram shows one placed at T C, which would reflect back a limited range of radiation, say in the green, which is recollimated by the lens T_1 and is retransmitted by the dispersing prisms. Its path, however, is now below the incident beam, and enters the prism D, which brings it into the field of vision of an eye placed at E, the focus of the lens O. It here fills one part of the field of view, while the other part is filled by light derived from three roof-prism reflectors placed in three selected spectral regions (in the present work red, green and blue-violet). These three spectral stimuli are therefore additionally mixed in that part of the field, and the result contrasts with the spectral test colour filling the other part.

The relative quantities of any one primary entering into colour matches are reckoned in accordance with an ordinary photometric scale, but the quantities relative to each other have to be established in terms of some other convention. Equal quantities *may* be taken, such that their mixture produces the sensation of "white." Thus if

$$R_1 + G_1 + B_1 = \text{White},$$

we may have any test colour C expressed by such an equation as

$$C = aR_1 + a'G_1 + a''B_1,$$

the total "quantity" of the colour in colour units being $a + a' + a''$. The quantities of the primaries are controlled by neutral wedges, which can be moved, but not read, by the observer. The readings are taken by an assistant. One of the most important applications of this instrument is to determine the colour mixture curves of the spectrum for various observers. In this experiment the quantities of the primaries necessary to match, by their mixtures, a series of spectral test colours are determined. It is quickly found that a mixture of spectral red and green looks pale against a spectral yellow, although the hue may be matched accurately. In order to get a colour match in the field of view, therefore, another prism suggested by D P in Fig. 4 can be put into the spectrum from which the test colour is derived. Thus if the test colour is a yellow, D P is made to yield a separately determined "quantity" of blue,

which desaturates the spectral test colour, giving an equation:—

$$C + qB = uR + vG + wB$$

$$\text{whence} \quad C = uR + vG + (w - q)\,B$$

Such equations may contain negative coefficients, but the series of equations provide means of plotting colour-mixture curves, which are very convenient in comparing the colour vision of different individuals.

The advantages of Mr. Wright's apparatus are its absence of stray light (this has been the great trouble in earlier work) and the high intensity in the field of view. It can be used either as an instrument for investigating colour vision, or as a "colorimeter" for measuring the colour of objects. Mr. Wright says: "The hue-sensibility curve for a number of observers could be determined; a determination of the number of saturation steps between the spectral colours and white . . . could be undertaken; . . . data on colour blindness, colour fatigue and adaptation might be obtained."

This fundamental work on the physiological basis of colour measurement is very important, because it helps to remove doubts about the possibilities of colorimetry for observers who seem to make slightly abnormal colour matches. If it appears that the trouble is mainly that of macular pigmentation, the provision of a suitable correcting filter should be sufficient to ensure normal colour measurements. This has no reference, of course, to colour-blind observers.

Efforts are being made to put the standards for colorimetric work on a satisfactory basis. It is possible to define three satisfactory spectral primaries by the homogeneous radiation of certain spectral lines as suggested by Guild, but a really satisfactory "standard white" is still required. However, the adoption of standard primaries would be a great advance. Some colorimeters use coloured light derived from colour filters for primaries. Suppose that the arbitrary primaries of the instrument, then, are R_1, G_1, B_1. A colour measurement expressed on this system may be

$$C = \alpha R_1 + \alpha' G_1 + \alpha'' B_1.$$

Let the standard primaries be R_2, G_2, B_2. In order to express the unknown colour in terms of the standard we must find the coefficients in the equation:—

$$C = \beta R_2 + \beta' G_2 + \beta'' B_2.$$

This can evidently be done if we know R_1, G_1, and B_1 in terms of R_2, G_2, and B_2. Guild showed how to escape from the tedious use of calculations based upon the "primary-sensation stimulations" by actually measuring R_2, G_2, B_2 in terms of the primaries of the instrument. This, of course, can only be done if it is possible to introduce a measured amount of "desaturating primary" into the field with the test colour (or a measured amount of white). However, if we can obtain measures for the standard primaries,

$$\lambda R_2 = lR_1 + l'G_1 + l''B_1$$
$$\mu G_2 = mR_1 + m'G_1 + m''B_1$$
$$\nu G_2 = nR_1 + n'G_1 + n''B_1$$

these equations, together with the condition that the units in each system shall add to make the same amount of white,

$$R_1 + G_1 + B_1 = R_2 + G_2 + B_2$$

are sufficient to eliminate λ, μ, and ν and obtain the expression required, giving R_1, G_1, and B_1, in terms of the standard primaries.

The Standard White.

A word as to the standard white. Psychologically, the sensation of white may be experienced under various conditions of stimulation. Thus it is most difficult to compare the colours of various ordinary illuminants when their light is experienced separately, for all may seem white until simultaneous contrast accentuates their relative differences, as in a photometer head. Certainly direct sunlight appears white. It is easy theoretically to define "white" as the quality of black-body radiation at a definite temperature, but the temperature must be so high that great difficulties are encountered in thermometry.

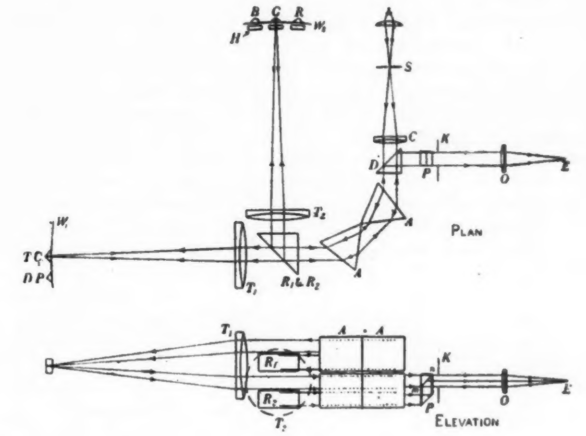


FIG. 4.

The best that can be done at the present time is to establish a more or less arbitrary standard, consisting of a lamp to be run at a definite voltage and current, which therefore emits a radiation of sufficiently constant quality. Other lamps of similar construction and materials may be standardized against the first by finding the electrical conditions under which they give light of the same quality (i.e., under which they have the same colour temperature). The lamps standardized by the National Physical Laboratory have the same integral colour, when run at the proper specified voltage, as a black body radiating at about 2900° K. A fairly reliable method of measuring the required voltage for this colour temperature is by comparison with an Eastman Kodak Acetylene flame standard.

The standard lamp is used with a liquid filter prepared according to a definite chemical formula which changes the energy distribution to similarity with that of a black body at, say, 5000° K, which may be taken as an arbitrarily fixed "white."

Checking the Colour Temperature.

The colour temperature of such electrical standards is changed with use, and periodic re-standardization is necessary. The use of a flame for checking is perhaps a little liable to uncertainty, and I recently suggested to a research student in the Technical Optics Department, Mr. R. H. Colborne, that he might examine the possibility of checking the integral colour temperature of a colour-standard lamp we were using, by comparison with a mercury arc. The experiments which he began could not be completed, but it was found that the light of a gasfilled lamp could be modified to the colour of the light of the mercury lamp by using two filters in series, one of copper sulphate and one of potassium permanganate or cobalt sulphate solution, the latter to provide a slight correction only.

The only mercury lamp available was of the Gallois vacuum type in quartz. Quoting from Mr. Colborne's report:—

"There seems to have been no work done on the particular point which arises in this experiment, namely, if the integral colour of the mercury arc is constant or varies with voltage and current, or from lamp to lamp. Stockbarger* has carried out experiments to determine how the intensities of the various regions of the spectrum —ultra-violet, infra-red, etc.—vary according to voltage, power, input, etc., but has not investigated whether or no the *relative* intensities of the visible lines change, although it seems probable from his paper that they do. It is known that as the mercury lamp heats up the lines broaden, but unless this takes place to any great extent the colour of each line will remain practically unchanged, and unless their relative intensities change there will be no change in the integral colour. This point was tested directly by measuring the colour on a trichromatic colorimeter and finding its variation with time and voltage." Mr. Colborne adds that it would be more

* *Jour. Opt. Soc. of America*, 14 (1927), 356.

desirable to investigate a lamp working at atmospheric pressure (such as the KBB type), but failing one of these his work was done with the vacuum lamp.

The results obtained are given in the following table. The colorimeter readings are on an arbitrary scale and were made with Mr. Wright's instrument, using spectral primaries: —

TABLE I.

Time in Minutes	Voltage	B	G	R
		Relative colorimeter coefficients		
0	19	33.6	38.9	27.5
1	26	34.0	38.0	28.0
2	27	30.6	40.7	28.4
3	31	28.0	38.1	26.9
4	33	29.8	39.4	30.8
5	34	27.9	40.8	31.3
6	36	29.1	39.8	31.1
7	37	29.5	39.6	30.9
8	39	28.8	40.4	30.8
10	39	29.5	39.2	31.3

These figures are plotted in the diagram, Fig. 5, which shows that a reasonably constant colour is obtained after a time.

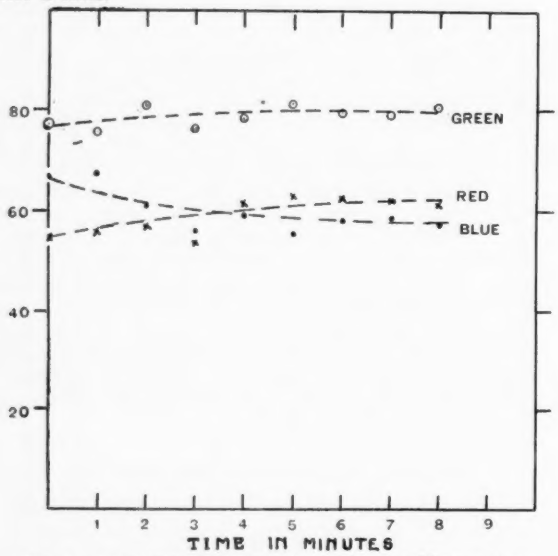


Fig. 5.—Colorimeter Coefficients for Light of a Mercury Arc.

The variation of colour with voltage was next studied. As the voltage is increased the colour was found to become less blue; there was a continuous variation over the voltage range used (38.2 to 20.8), but it may be said that the colour variation is not nearly of such magnitude as that encountered in metal-filament lamps. The main results give grounds for thinking that if an atmospheric type of lamp were run at a carefully regulated pressure and voltage the colour should be fairly constant.

The main difficulty in such a case is encountered in the variation of colour vision of different observers due to macular pigmentation, for a comparison must be made of colour between two lights of very different energy distribution, one of a practically spectral type, the other of isolated bright lines.

But *one observer* might find the mercury lamp in this way a useful colour standard for checking his tungsten lamps. If another observer wished to use the same standard he would have to make sure that his colour vision was identical with that of his colleague (improbable) or correct his vision by the use of a suitable filter. The difficulties involved, however, are only the same ones as those ordinarily encountered in trichromatic colorimetry.

I have no idea whether or no the macular pigmentation of a person is liable to change from time to time.

Physical Methods of Control in Colorimetry.

The uncertainties attaching even to "normal" human colour vision makes the thought of physical methods of colorimetry and colour standardization seem more than ever attractive. The interesting papers on photo-electric colour matching from the laboratory of the G.E.C. *may* be only early ones in a series by which the complete technique of physical colorimetry will ultimately be established.

The methods of use and the characteristic behaviour of photo-electric cells are now receiving a great deal of attention in various quarters, and already they have a number of interesting technical applications. Thus, the cadmium cell, provided with a suitable filter of Uviol glass, has a sensitivity curve shown by the full line 1

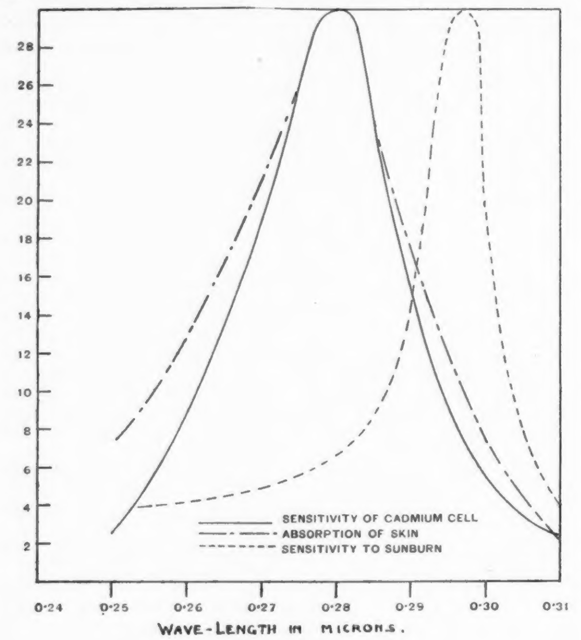


Fig. 6.

in Fig. 6. Curve 3 is one which represents the relative sensitiveness of the skin to erythema or "sunburn" effects, according to Dorno and others, while Curve 2 shows the relative absorbing power of the skin for radiation of the different wavelengths, according to Hasselbach.

Such a cell can be used to integrate the "biologically effective" radiations, and give relative quantitative results. As produced by Günther and Tegetmeyer, Braunschweig, it is being used nowadays in meteorological and climatic studies in connection with anti-tuberculosis work. The above paragraphs have, of course, no strict reference to colour, but it will now be understood how a group of three cells with sensitivity curves having maxima in (say) the red, green, and blue regions of the spectrum would give responses of which the relative magnitudes would be unique for a given colour.

A suitable group of three cells would provide a complete "colour-measuring" system, but one difficulty at present seems to be that it is not yet possible to reproduce cells having exactly the same frequency-sensitivity characteristics. Then, a "colorimeter" is of little practical use unless its measurements can be re-interpreted in terms of colour as perceived by the normal eye. This latter condition would be difficult to fulfil unless the frequency-sensitivity curves can be made to agree with suitable "primary sensation curves"; evidently this latter requirement is a step of great refinement, and not necessarily possible unless it is found to be so by some fortunate chance.

Photographic Colorimetry?

Physical photometry has a useful side in the recent developments of photographic photometry, which are proving of marked value in the study of the intensity distribution in spectra. Nobody has been rash enough to suggest photographic colorimetry, although it might at first glance seem only another step onwards from colour photography. We are still, however, so far from being able to guarantee a *truly* correct reproduction of a colour when photographed that colour photography must surely still have a long way to go. Nevertheless

some creditable results are being obtained, and the new method of colour snapshots has been rendered possible by the employment of a new emulsion of hitherto unattainable properties, being more sensitive at the red end of the spectrum than at the blue. A tri-pack is used, in which this "red-sensitive" film is placed first, followed by "green-sensitive" and "blue-sensitive" layers. In accordance with the usual method, the first image is printed in the blue of the "blue subtractive primary," the second in the crimson-red, and the third in yellow. The blue image, being from the first film, has perfect definition, and secures good "drawing" in the final image; the rear film printing in yellow is more diffuse in the image, but serves to correct the colour. It is not claimed, of course, that the method offers more perfect colour rendering than extant processes, but that it offers the possibility, hitherto out of the reach of all except those with very special apparatus, of taking snapshots in colour.

Colour Names.

Only very slow progress is made with the question of standardizing colour names and the specification of standard coloured surfaces. I was told that a first requirement of the launderers' research associations was to find a standard white surface.

Magnesium white, coated from burning magnesium ribbon, is easily prepared fresh, and has many advantages.

A committee of the British Engineering Standards Association has had the utmost difficulty in preparing standard specimens, for which the names could be readily agreed upon, for ready-mixed paints. A survey of the specimen cards issued by various makers revealed a very great divergence amongst the use of such colour names as sky blue, light buff, and so on. The standards are now in course of final revision, and will be published ultimately with the colorimetric constants determined by Guild's colorimeter, so that they can be checked from time to time.

This work has proved difficult enough, and it is to be hoped that the advantages of standardization will appeal to all who realize what industrial and commercial difficulties arise through the existing divergencies. International co-operation in such efforts is most desirable, but difficult to secure.

The present paper has touched on a number of very diverse topics. My main object has been to awaken interest in some of the present lines of work. All science and scientific progress is built up upon such "interest," which, like Bacon's *Garden*, is one of the purest of human pleasures.

Problems in Illuminating Engineering

The **next meeting** of the Illuminating Engineering Society, which is to be held at the Home Office Industrial Museum (Horseferry Road, Westminster, S.W.1), at **6-30 p.m.,** on **Tuesday, February 19th,** is to be devoted to **"Problems in Illuminating Engineering."** A series of short contributions by different authors, dealing with typical modern lighting problems, will be presented. Contributions on such subjects as the lighting of underground railway junctions, halls, tennis courts, etc., have already been promised, but the Hon. Secretary would be glad to hear from any members who have interesting problems and solutions to present. Even if such problems do not figure amongst the introductory contributions they might well be raised in the subsequent discussion. Informal meetings on these lines have proved exceptionally successful in the past, and we hope that as many members as possible will take advantage of this opportunity of "pooling" information for the general benefit.

Illuminating Engineering in Germany

We have recently received from the German Illuminating Engineering Society a booklet containing the complete proceedings at the annual congress held in Hamburg in 1927. The papers fall into two distinct groups. Five of them deal with the effect of light on the eye, and both lighting experts and physiologists are included amongst the authors. The remaining three contributions deal with the lighting of docks, navigation lights and beacons, etc.—subjects of special local interest in view of the congress having been held in Hamburg. The system of publishing together groups of papers dealing with allied subjects has much to recommend it, and this booklet would doubtless be of interest to British readers.

World Engineering Congress in Japan, 1929

A conference of representatives of twenty-three institutions and societies took place recently at the Institution of Civil Engineers in connection with the above Congress, which is to be held in Japan during October 29th to November 22nd this year. With a view to securing adequate British representation at this Congress, a small executive committee has been formed, of which Sir Brodie Henderson is chairman.

Illuminating Engineering Society

(Founded in London, 1909)

TWENTIETH ANNIVERSARY DINNER

Wednesday, February 13th, 1929

REMINDER

Members have already received intimation of the DINNER which will be followed by Dancing and has been arranged to take place on WEDNESDAY, FEBRUARY 13th, 1929, to celebrate the Twentieth Anniversary of the Foundation of the Illuminating Engineering Society.

The Dinner will be held at the TROCADERO RESTAURANT, Piccadilly, London, W., and the price of the tickets will be 15/- (exclusive of wine). The Dinner will commence at 7 for 7-30 p.m., and will terminate between 9—9-30 p.m., after which a hall will be available for Dancing.

Any members who have not yet applied for tickets are asked to make a special effort to support the President and Council by their presence on this occasion, and to bring with them, as guests, friends who are in sympathy with the aims and objects of the Society. Members may bring ladies as their guests.

Applications should be addressed to the Hon. Sec., Mr. J. S. DOW, 32, Victoria Street, London, S.W.1.

The Application of Electric Lamps to Advertising

In what follows we give a summary of the discussion of Mr. H. Lingard's paper on the above subject, which was presented at the meeting of the Illuminating Engineering Society on December 11th, 1928, and appeared in our last issue.

THE PRESIDENT (Mr. C. C. Paterson), after congratulating Mr. Lingard on his interesting paper, called upon Dr. J. W. T. WALSH to open the discussion.

Dr. J. W. T. WALSH said he was sure that it would be the view of all present that Mr. Lingard had produced an excellent paper, interesting not only for the matter it contained but for the manner in which it had been presented. He had been specially struck by the treatment of irradiation, because this was a subject of interest to the physicist as well as to the electrical advertiser. He wondered why so little use was made in electrical signs of the internally frosted lamp. Presumably the use of obscured lamps would help towards securing merging of the individual sources and the formation of continuous letters at relatively short distances. He would also like to know whether Mr. Lingard had any information of the effect of colour on irradiation, i.e., was the irradiation greater or less with red light than with blue light? There appeared to be no mention in the paper of the optimum ratio of the breadth of the letter to the height. In the case of dials painted with radioactive luminous material the best ratio had been found to be about 1 to 6 or 1 to 7. Did a similar ratio exist in the case of luminous signs? Dr. Walsh also inquired why the B1 figures were expressed in hundreds. Would not units or tens do equally well?

In conclusion, Dr. Walsh drew attention to the important applications of electric signs on the railways. The Southern Railway had made good use of them on some of its lines, and he hoped that other railways would follow their example.

Mr. A. CUNNINGTON (Southern Railway) emphasized the importance of easy maintenance in the case of signs used on railway systems. The tendency of objects exposed to the smoky atmosphere of railway stations to deteriorate was not sufficiently realized. Some of the lighting devices brought to him for inspection would not last six months in such an atmosphere. In many cases also the framework was too light and the fittings were not sufficiently robust. In some cases designers seemed to be under the impression that their appliances would withstand weather conditions and corrosion indefinitely.

Mr. A. W. BEUTTELL complimented Mr. Lingard on his paper. Some of the data was new to him, and much of the information given was extremely valuable. It would be interesting to know if corresponding data applying to signs of the enclosed variety had been collected. Although the field for the enclosed sign was somewhat less extensive than that existing for the exposed type, there were now a considerable number of signs of the former type in use. The conditions were somewhat different, as letters were usually confined by clear lines rather than by a number of spots. When letters tended to run into one another at a distance this was usually due to irradiation. In many cases, however, the letters were too thick or too close together. He had seen no data which would aid definitely in determining the spacing and the relation of the thickness of letters to their height.

He did not quite follow the principle underlying the relation of irradiation to contrast, i.e., variations imposed by differences in the brightness of adjacent signs or in the ratio of the brightness of a sign to its background. He would imagine that greater brightness would cause the pupil of the eye to contract, and, the aperture being smaller, there might be better definition.

Mr. J. M. WOOLNOUGH, speaking as a manufacturer of electric signs, expressed his great interest in the paper. He agreed that the construction of some signs left much to be desired. This was in part the fault of the advertiser, but there were also a number of the smaller manufacturers of signs who were not familiar with the principles underlying sound design and did not work to any standard. It would pay advertisers, when considering the erection of a sign, to make sure of obtaining expert advice. The Master Sign Makers' Association, which included amongst its members many of the leading manufacturers of electric signs, had used their influence to promote sound methods of design, and had prepared standard specifications in which some of the most important principles of construction and design were outlined.

Mr. T. E. RITCHIE expressed the hope that Mr. Lingard's excellent paper would be brought to the notice of users and purchasers of advertising devices, and especially electric signs. Importance was rightly attached to correct spacing and selection of the right number of lamps. In these respects signs not infrequently proved disappointing. Some makers were apt to attempt to diminish the number of lamps unduly in order to reduce either the initial expenditure or the running cost, with the result that signs that were otherwise excellent in design were spoiled. This remark also applied to some forms of box signs. Mr. Lingard had spoken of signs being underlighted, but in many cases the main fault was the use of lamps of excessive power at too great intervals. Unfortunately purchasers of signs not infrequently only become aware of this defect when it was difficult to remedy it.

Mr. L. E. BUCKELL likewise expressed appreciation of Mr. Lingard's paper and the very able demonstrations by which it was accompanied. They had seen examples of almost all the methods that could be applied to signs, and he would like to mention the display of enclosed signs as particularly interesting. It had struck him as curious that some of the examples were new to him, and he could not recall having seen them in use in London.

Reference had been made to the lighting of house numbers. He believed that in some cities abroad there was local legislation making the use of such illuminated figures compulsory. He saw no reason why a similar enactment should not be applied to cities in this country, at any rate in the suburbs of London.

A section of the paper had been devoted to signs required to be seen at great distances. In England it was often difficult to find a site for such signs, and in some towns it was almost impossible. The author's illustration had shown what might be described as a model site, i.e., tall buildings at the edge of an area containing none of similar height. He was surprised that advertisers did not make greater use of sites along main railways. Almost anything that attracted one's attention during a railway journey was likely to make an impression.

Experience had shown that in the case of signs to be viewed at distances up to 50 or 100 yards a much clearer effect was often obtained by the use of sprayed lamps, such that the whole area of the bulb became luminous. Small series lamps, taking only 14 volts, had been in use for a number of years, and with them very beautiful curves and clearness of lettering could readily be obtained.

Irradiation had been studied mainly from the standpoint of obtaining a continuous line. In some cases a more important aspect was the prevention of coalescing parallel lines, i.e., making sure that parallel lines did not run together. One of the functions of the trough system was to prevent the light from "spilling over." Possibly also the trough had the additional advantage that reflection of light helped to fill the gaps between lamps.

The paper contained most useful information on the general design of electric signs, but he doubted whether sufficient importance had been attached to the use of colour. On the other hand, he had observed in in Germany, and to some extent in this country, a tendency to fill in the available space with "jazz" patterns in various colours. Such designs were often difficult to distinguish. The paper had the merit of

breaking new ground, and it should encourage the introduction of better methods of advertising.

Capt. W. J. LIBERTY referred to the important field for illuminated signs in connection with notices for the guidance of traffic. He had noticed, in such cases, instances of irregular spacing of lamps, which gave very unsatisfactory results. In the case of signs of this nature even illumination over the surface to be revealed was of great importance. He agreed with the author that the lighting-up of numbers and names of houses represented an important new field. This matter should be brought to the notice of local authorities.

Mr. J. S. DOW remarked that much of the information in regard to dimensions of letters and the effect of irradiation was quite new. It was, he believed, the first time that definite recommendations on this subject had been made to members of the Society. In regard to irradiation, he thought that the peculiarities of individual eyes must play an important part. Spreading of light might be accentuated by a film of moisture over the eye-lens. To some eyes small distant bright lights appeared as a central luminous spot with bright streamers radiating from them. Dr. Walsh had raised the question of the effect of colour. He (Mr. Dow) had discussed this point in a paper read before the Society early in the present year. His own eye was unable to focus blue light at a distance, but obtained a sharp image of red, and this seemed to be the most usual impression, though there were some people who obtained the converse effect. Apart from this, it was, he thought, general experience that distant red lights had greater luminosity than blue or green ones.

Several speakers had referred to regulations in foreign cities relating to the use of illuminated house numbers. He believed such a regulation had been made in Helsingfors (Finland), and in Germany special companies had been formed to supply such illuminated devices at a small annual rental. The use of illuminated signs was sometimes unduly hampered by restrictions. It seemed to be overlooked that such signs were often desirable for purposes of giving information rather than as advertisements. There were many public buildings which might well be identified in this way.

(*Added*): Since this discussion took place Mr. WOOLNOUGH has kindly sent me copies of two specifications issued by the Master Sign Makers' Association relating to signs constructed respectively of metal and wood. In the former case the number of holders for the upright stroke for signs of different sizes is specified, and in the latter also the minimum thickness of letters.

Mr. C. E. GREENSLADE inquired why makers of signs habitually used block letters. In ordinary reading matter such letters were only used for capitals. He thought that signs would be read more easily if conventional practice were followed and "lower-case" letters used, except for the initial letter. He rather doubted the statement regarding the limit of one minute of arc. He would also like to know why the 60-watt lamp in Fig. 2 should appear larger than the 10-watt lamp. Mr. Greenslade also referred to the problem of the comparative visibility of black letters on a white ground and vice versa.

Mr. W. J. JONES briefly expressed his interest in the paper. Most of those who, during the past few months, had been making observations of signs in various parts of London had been amazed at the neglected conditions of many signs and the poor quality of the illumination. In walking along the Strand one could appreciate how poorly many forms of box signs stood out from their surroundings, and it was evident that the relation between the brightness of signs and the general "district brightness" was a most important one.

Mr. H. H. LONG expressed his great interest in the paper. He was not quite clear how the curves in the earlier part of the paper were obtained, and it would be useful to have fuller data on this point. Reference had been made to the comparative visibility of black letters on a white ground and the converse arrangement. He had studied this problem in connection with floodlighting schemes, and had come to the conclusion that white letters on a black background gave much better visibility—at any rate so far as surfaces revealed by reflected light were concerned. Experiences of investigators in the United States supported this view.

Mr. J. L. H. COOPER congratulated Mr. Lingard on his paper. He had illustrated very clearly the importance of correct methods of design and installation. He (Mr. Cooper) was impressed by the vast field of development presented by the electric sign. He wished to emphasize particularly their value for the purpose of giving information; signs should be installed near the boundaries of every important city informing motorists of the locality of garages and hotels.

Mr. H. LINGARD, in reply to Dr. Walsh, agreed that the internally frosted lamp should have a considerable future in connection with electric signs. The fact that up to the present lamps of this kind were not employed in any numbers for this purpose was probably due to the fact that, being a recent development, this process had not yet been applied to sign lamps.

With reference to the point raised on the effect of colour on irradiation, he regretted that he had no definite data, although it seemed logical to assume that the use of coloured lamps would diminish irradiation, since it naturally involves a reduction in brightness as compared with clear lamps. In connection with the last point raised by Dr. Walsh, the author was much interested in the figure of 1 to 6 or 1 to 7 for the optimum ratio of the breadth of the letter to the height. The usual figure for signs of trough construction was of the order of 1 to 8. He agreed that the B.I. factor might just as well have been expressed in tens as in hundreds.

In reply to the points raised by Mr. A. W. Beutell, the author stated that it was his opinion that irradiation was not likely to be a factor of great importance in the design of box signs, except in cases where black lettering was imposed on a white background which was illuminated to a very high intensity, under which conditions there was a certain tendency for the luminous surface to overlap the black letter strokes, and under these conditions the letter stroke would have to be widened to neutralize this effect. The minute of arc minimum angle for retinal discrimination had been determined by actual experiment. He did not think it was possible to give any theoretical justification, owing to the complexity of the factors involved.

In reply to the remarks of Mr. L. E. Buckell, the author indicated that the Lighting Service Bureau would certainly make every effort to bring these data to the notice of manufacturers and users of signs by the organization of lectures and demonstrations.

The point raised by Mr. Greenslade regarding the use of lower-case lettering for electric signs in place of the customary capitals was an interesting one, but the author would suggest that the reason for the use of block lettering in the majority of signs was due to the fact that lettering of this character gave an alphabet in which the letters were more uniform in size and were limited between two horizontal lines.

He indicated that the curves given in the paper dealing with the effects of irradiation were based on experimental results, and from these it appeared that in practice there was more irradiation with a 60-watt lamp than with a 10-watt, due undoubtedly to the fact that the former was contributing a greater volume of light to the eye of the observer.

In regard to the point raised by Mr. Dow, he could not say precisely how far the data might be subjected to variation with the eyes of the different individuals. The results presented, however, were typical of those obtained with the normal eye. He had not been able to include the effects of colour within the scope of the investigation. Colour, as applied to electrical advertising, was a fascinating subject, and one which might well be made the subject of a separate paper. Similarly, he had purposely omitted floodlighting, because this subject had been very thoroughly treated in an earlier paper before the Society.

In conclusion, he wished to thank those present for their kind reception of his paper, and in particular wished to express his thanks to Mr. T. Catten for his assistance in arranging the demonstration apparatus.

The Nineteenth Annual Exhibition of the Physical Society and the Optical Society

THIS annual exhibition has a field of its own, and is always looked forward to with interest. The display at the Imperial College of Science and Technology last month was again a very representative one. A feature on this occasion was the number of exhibits, especially in the Research Section, illustrating novel applications of light in the solution of scientific problems.

The first item in this section was a contribution by Mr. A. C. Barnard, of the National Physical Society, illustrating the properties of selenium cells. By an ingenious exposure of a cell to intermittent light, and the conveyance of the resultant varying current into a loud speaker, musical notes of varying frequency could be produced and—with a little practice—the National Anthem could be played. Light-sensitive cells again formed the basis of the new "photo-electric yarn-liveliness tester" exhibited by the British Research Association for the Woollen and Worsted Industries. The quality of a fabric depends largely on the "liveliness" of the yarn used, i.e., on its variation in diameter. It has been found that this variation can be conveniently studied by allowing the yarn to be drawn across a beam of light which impinges on a photo-electric cell. Changes in diameter of the yarn cause corresponding alternations in the intensity of light, and hence also in the current passing through the cell, which is measured by means of a Lindemann electrometer.

Photo-electric cells also figured in the exhibit of the research laboratories of the General Electric Co. Ltd. A physical integrating photometer, incorporating a red-sensitive photo-electric cell, and capable of measuring vacuum and gasfilled lamps of 20 to 100 watts was shown. The apparatus is stated to be capable of measuring to an accuracy of ± 0.25 per cent. in lumens, so that it has evidently considerable possibilities for accurate photometric work. Another demonstration by the same exhibitor showed the use of photo-electric cells for the detection of smoke or dust in gases. A beam of light is passed through the air or gases to be studied, and is viewed sideways by means of a photo-electric cell. If the medium is quite clear the cell should receive no light. But if it contains some scattering particles some light is emitted sideways, and the current through the cell is influenced accordingly. The apparatus was designed primarily to indicate any failure in a plant for purifying blast-furnace gas, but it has doubtless other applications.

Another exhibit by this firm showed a simple but novel application of light to the automatic control of titration. This was shown applied to an acid-alkali titration with methyl-orange as the indicator. The change in the light transmitted by the solution, with a blue filter behind it, stops the supply of acid as soon as the colour change of the indicator takes place.

An exhibit by the Meteorological Office (Air Ministry) included a "sky photometer" designed for testing the visual intensity of daylight. An image of a candle flame is thrown on the underside of a horizontal translucent screen, exposed to the sky. The screen and image are observed, reflected in a mirror, through the aperture of the instrument. By adjusting the aperture of a diaphragm in front of the lens forming the image its brightness can be adjusted until equality results. During gloomy periods the insertion of a dark glass enables a still further reduction in the brightness of the image to be made. This apparatus is evidently simple in design and operation—a point of some importance in view of the fact that observations of sky-brightness may have to be made in isolated localities. But, apart from this circumstance, it would seem that the photometric design of the instrument might be improved.

Amongst other exhibits in this section we may mention the ultra-violet micro-photomicrographs exhibited by Dr. L. C. Martin and Mr. B. K. Johnson, which illustrate how the resolving power of a microscope may be increased by reducing the wavelength of the radiation used. Some interesting scientific optical illusions were staged by Dr. R. S. Clay, and Professor Scripture, of the University of Vienna, showed some of the apparatus developed by him for the graphic registration of speech—a line of investigation which seems to have great possibilities.

A brief reference should also be made to the series of historical exhibits, contributed by Mr. Thomas H. Court, Mr. R. W. Paul and the Science Museum—the latter an interesting display of early clocks and primitive time-measuring apparatus, including clocks based on the flow of sand and water and shadows cast by the sun.

The general exhibits were, as usual, chiefly representative of optical and physical instruments. There were a number of photometric appliances on view. The latest model of the Holophane lumeter was shown by the Wray Optical Works Ltd., and the new Hilger-Nutting spectrophotometer figured in the comprehensive exhibit of spectroscopic apparatus by Messrs. Adam Hilger Ltd. Two instruments shown by the Cambridge Scientific Instrument Co. Ltd. deserve special notice, the photo-electric micro-photometer and the "opacity meter," the latter based on a design of the Bureau of Standards and involving the comparison of the object tested with two standard surfaces—one a standard black, the other a standard white. The standard black was obtained by painting the interior of a sphere a dead black, and the standard white was constructed in the form of a disc coated with magnesium carbonate.

The Thermal Syndicate Ltd. exhibited vitreosil and fused silica ware and ultra-violet producing units, and there were other exhibits illustrating actino-therapy. A feature of the exhibit of Messrs. Carl Zeiss (London) Ltd. was the demonstration of fluorescent materials, and the discrimination between genuine and spurious gems and other experiments performed by the aid of ultra-violet light.

Sheffield Illumination Society

We have received a copy of the syllabus for 1929 of the Sheffield Illumination Society, of which Mr. J. F. Colquhoun is President, and which, we believe, does excellent work. In the programme before us social and educational events are agreeably mingled. We notice that on February 4th Mr. R. G. Williams is dealing with "Colour Lighting." On February 25th Mr. J. F. Colquhoun will give an account of his experiences in America, and on October 14th Mr. F. L. Nichols is to lecture on "Lamps, Ancient and Modern." The annual outing to York is on June 22nd, and there are also visits and social evenings.

The Electrical Association for Women

We have received from the Electrical Association for Women particulars of the spring fixtures, 1929. Several of these events, including the lecture by Mr. A. B. Read on "Modern Decorative Lighting of Interiors," have already taken place. The programme for the immediate future includes a talk on "The Construction, Use and Maintenance of Electric Sewing Machines" (February 19th), an "At Home" on March 6th, and a visit to the Ideal Home Exhibition on March 13th. On April 16th there will be a luncheon at the Hotel Cecil, presided over by Mrs. Wilfrid Ashley, at which Sir John Snell, Lt.-Col. K. Edgcumbe and others will speak.

Attention may also be drawn to the series of evening lectures arranged by the Association's Committee of Women Demonstrators. On January 29th Mr. F. W. Purse described the generation of electricity at West Ham. On February 12th Mr. H. de A. Donnisthorpe is to lecture on "Radio Progress and its Connection with the Thermionic Valve," and on March 19th Mr. H. Bourne will give a chat on "Some Elementary Facts Concerning Electric Motors."

POPULAR & TRADE SECTION

COMPRISING

**Installation Topics—Hygiene and Safety—
Data for Contractors—Hints to Consumers**

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Electric Lamps in Mines

A PROPHETIC PICTURE.

This old print is taken from Professor G. Mantica's work on electric lamps.* It is intended to illustrate a demonstration by De Changy, an engineer who was born in Turin but migrated to Brussels, and who in 1850 had the idea that incandescent conductors in a

De Changy presenta al suo ingegnere in capo la prima applicazione della sua lampada ad incandenza.

hermetically sealed glass envelope might form the ideal illuminant for mines. This early conception of the electric lamp, as we know it to-day, is of considerable interest in connection with Mr. Swinburne's recent instructive account of pioneering work in this field.

Local Units for Industrial Lighting

The general lighting of factories has tended to become standardized during recent years, and it is apt to be assumed that well-designed overhead lighting will invariably " fill the bill." That illumination on these lines has manifest advantages cannot be denied, and there are many cases in which it serves the purpose. It should not, however, be assumed too readily that all problems can be dealt with in this way, and there still remain opportunities for the use of well-designed local units.

The two adjacent illustrations (Figs. 1 and 2), for which we are indebted to Messrs. Korting & Mathiesen Electrical Ltd., are cases in point. The first picture shows the local lighting of a cylinder which is being bored on a lathe. In this case it is desirable that light should penetrate into the interior of the aperture, and this cannot always be ensured by general lighting, however well diffused. The second illustration shows a series of local units assembled to illuminate mass production work on a moving band. Such work is done at high speed and requires very careful inspection, so that a high illumination is necessary. This high

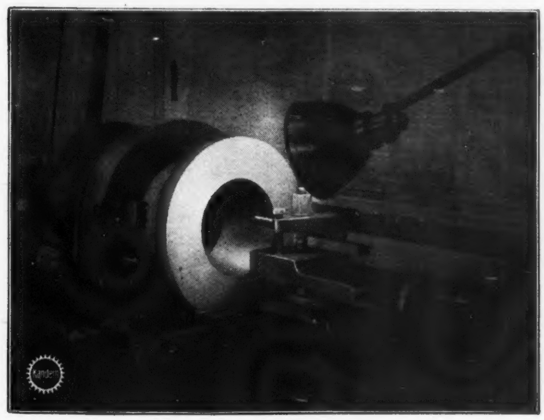


FIG. 1.—A Special Case for Local Lighting: Boring out a cylinder.

illumination can be economically furnished by local units, and the fact that the moving band is flooded with light whilst the rest of the room receives more subdued illumination is probably an advantage. An overhead unit is also provided to furnish moderate general illumination, thus relieving excessive contrasts—a point

FIG. 2.—Showing Application of Local Units to Mass Production work on a moving band.

that should always receive attention when local units are adopted.

Successful local lighting implies the use of well-designed robust fittings. The source should be *completely* screened from the eyes of the worker, and the unit should be easily adjusted into any desired position.

* Le Nuove Lampade Elettricihe ad Incandenza, by G. Mantica (Milan, 1908).

Some First Impressions of the United States

By a Delegate to the I.C.I.

IT is an old saying that " second thoughts are best," and there is no doubt that first impressions can be most misleading, especially of anything so vast as the United States of America. To the stay-at-home Englishman no mere enumeration of distances or even study of the map can possibly convey an adequate impression of what that very vastness implies. To the average American, on the other hand, it is just a matter of course, and it is only the Englishman, brought abruptly into contact with American conditions, who perceives the full significance of the statement that the United States is not a country, as he is accustomed to think of countries, but is really half a continent.

Probably that is the first impression received by anyone who, like the delegates to the recent I.C.I. meetings, has been taken over a tour of some 3,700 miles during a period of a fortnight. That impression, however, soon yields pride of place to others connected less with America than with the American people.

America is essentially a new country and the American nation is a young nation. To an Englishman who is accustomed to live amid buildings and monuments of an age measured in centuries, and whose habits of thought are in no small measure moulded by the traditions of ten or fifteen centuries of English history, the youth of America comes with almost startling force. That great event in American history, the Civil War, is of such recent occurrence that a few participants in it still survive. The death of Abraham Lincoln, who is probably regarded by most Englishmen as the greatest American statesman, took place within the memory of many now living. Even the birth of the nation, at the Declaration of Independence, took place only 152 years ago. Even such facts as these do not present an adequate picture of the recency of this great nation. Fifty years ago the population was 50 million. It is now about 120 million. In other words, about 30 to 40 per cent. of the people who now form the United States belong to families which have lived on American soil for less than the average lifetime of an individual.

In view of these facts it is not surprising that the dominating impression on a visitor from the Old World is that of youthfulness in national life. In fact, there may easily be traced in many respects an analogy between the characteristics of the American people and those of the individual who has still to attain full development.

In the first place, it is impossible not to be impressed with the extraordinary energy everywhere displayed. Whether they are at work or whether they are at play, the Americans exhibit a constant activity, and the value set upon hard work is probably higher in the United States than in any other country. The doctrine that work is essential to prosperity and enobling to human nature seems to be accepted by all classes alike. Nature has put into the hands of this energetic nation not only enormous stores of power, but the results of the scientific and material progress of the nineteenth and the present centuries. The position is somewhat that of the heir to a huge patrimony. The situation is one which has tremendous possibilities either for good or for ill, for the betterment or the retardation of progress of the whole human race.

Fortunately for civilization, even a brief study of well-informed American opinion reveals that, in the people of this country, their energy is accompanied by high ideals and aspirations. Sometimes these are apt to be ego-centric, but their existence and real driving power cannot be doubted. The chief disadvantage is a geographical one. Comparative isolation has in the past tended somewhat to hinder a sympathetic understanding of the outlook and modes of thought of the older nations and of the peculiar problems which confront them. Only more frequent and extended intercourse between Europe and America can overcome this obstacle, and here, naturally, England must play a large and unselfish part. Geographically part of Europe, and racially of such close kinship with America, the English nation should form the link to bind the two continents together. British statesmen and, still more, the British people as a whole have a wonderful opportunity and a weighty responsibility in this respect. England and all Englishmen should deliberately do all in their power to cultivate friendship with the American people. That way lies the best chance of the future peace of the world.

Now friendship implies understanding, and understanding can only be achieved by intercourse. The exchange of ideas by means of the written word is valuable. Telephonic communication is still more valuable, especially when it is developed to the stage which makes possible such a thing as the joint meeting of the Institution of Electrical Engineers and the American Institute of Electrical Engineers, held simultaneously in London and in New York this year. But best of all is personal intercourse, the " heart-to-heart " talk, appreciation of the " other fellow's point of view," his conditions of life and the ideals and aspirations of those by whom he is surrounded. Such intercourse can only be achieved by exchange of visits, and the urgent necessity for making this exchange as easy and as frequent as possible cannot be overestimated. No one who took part in the meetings of the International Commission on Illumination last September, and the wonderful tour which preceded them, can have failed to obtain an understanding of American conditions which no amount of correspondence or perusal of published literature could in the least convey.

To cite just a single example, most of those who have not seen American cities for themselves have a firm conviction that skyscrapers are inherently ugly, and cannot be anything else. A personal visit brings about a realization of the fact that this is not the case, and that America has developed a new school of architecture. In fact, it is probable that American architects are responsible for the most profound alteration in the principles of architectural design that has taken place since the Middle Ages. This is, perhaps, in contrast with the position in respect to the other branches of art. Art galleries of splendid design and ample dimensions are there in abundance, it is true, but they are built, one feels, for the future. America naturally possesses few gems of the graphic and plastic arts, such as crowd the antiquated and ill-designed galleries of Europe. Is it a heresy to suggest that some arrangement might be made by which Europe furnished America with some of its art gems of the first water in exchange for funds to be used in the building of galleries which would house the remainder in a manner more suitable to their true worth? The popular prejudice against the removal of art treasures to America seems now to be a survival of a narrow parochialism which must sooner or later give way before a more enlightened spirit of willingness to share our priceless artistic heritage with our cousins across the Atlantic.

It is difficult to pick out for special mention any items in the long list of " first impressions " which the visitor to America cannot fail to register in his mind during his first few days on American soil. The voluminous nature of the newspapers, the *non*-universality of the chewing-gum habit (contrary to expectation), but, on the other hand, the welcome ubiquity of iced water, self-service restaurants, paper towels, the quick response " You're welcome " to your cursory " Thank you," the almost unfailing courtesy in shops, subway, taxi and railroad; all these are mingled with a general impression of the universal delight in mechanical devices—some might call them " gadgets." The payment of fares on a Fifth Avenue bus, the production of a pat of butter in your hotel, the selling of postage stamps, and (most fruitful field of all) the delivery of soap in the washing-places of hotels, clubs and restaurants are all performed by mechanical means, to the occasional confusion of the stranger and, one hopes, the lasting enjoyment of the native-born American.


PEARL
MAZDA
LAMP
MADE IN ENGLAND
PEARL
MAZDA
GASFILLED
B.T.H. PATENT
For every lighting need instal
B T-H
PEARL
MAZDA
LAMPS
MADE IN ENGLAND
3162
THE BRITISH THOMSON-HOUSTON CO., LTD.
CROWN HOUSE, ALDWYCH, LONDON, W.C.2.

There is, however, one impression which predominates over all the others, and that is the impression of continuous and rapid change. This may be regarded as another symptom of the spirit which pervades the American nation. Tradition is almost absent, whether to hamper or to stabilize. The result is a far greater initiative in undertaking new enterprises and a freedom of action which is rather the exception than the rule in Europe. Huge blocks of buildings of comparatively recent date are demolished and replaced by larger or more up-to-date blocks with a readiness which astonishes the newcomer. The result is a capacity for rapid progress which is probably unique.

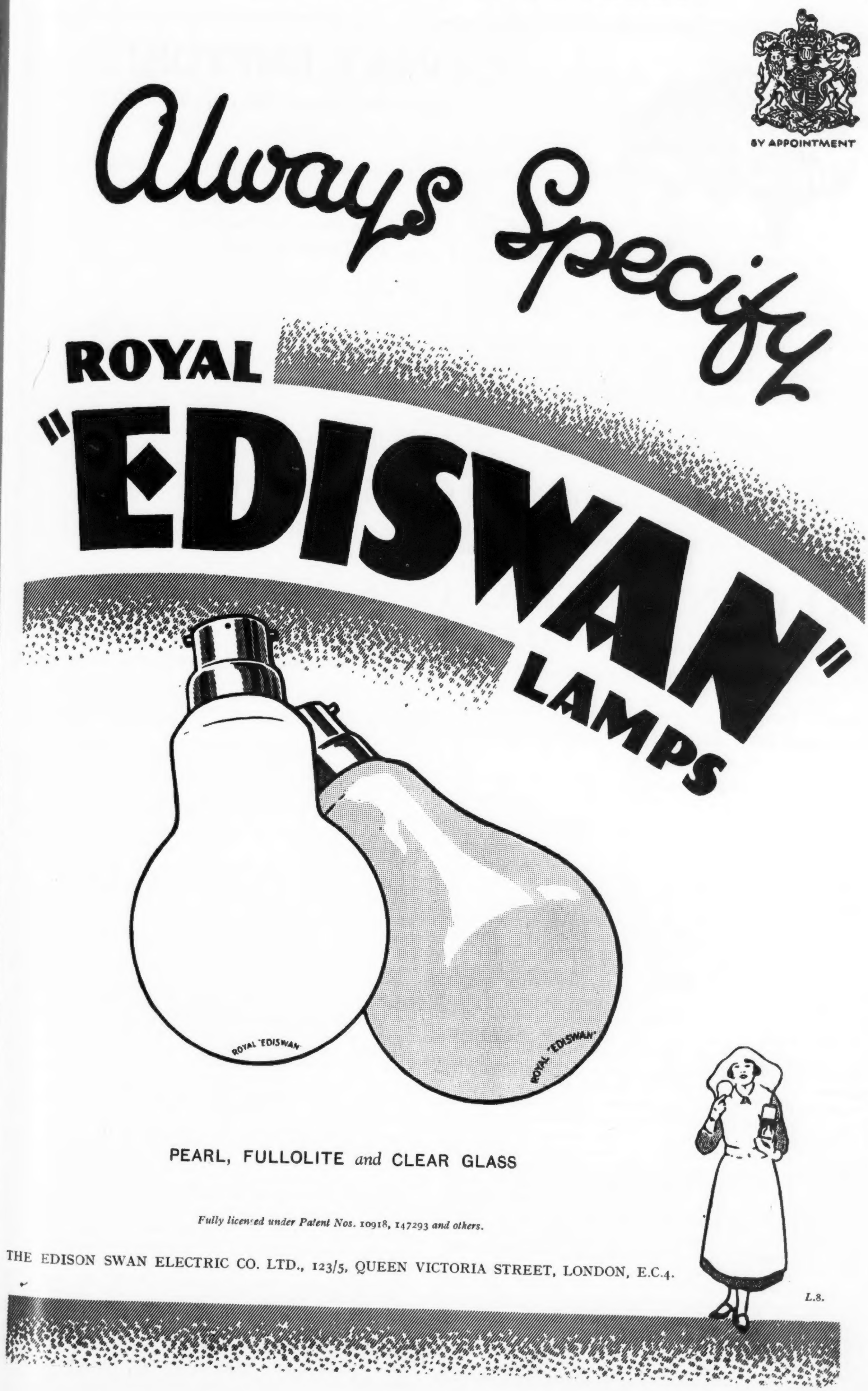
What is true of buildings is equally true of careers. The labour turnover in America is extremely high, but although this is, in itself, a handicap to industry it is a symptom of the willingness to " take a chance " in the search for something better that is, for the most part, lacking in the members of the older civilizations. The number of men of eminence in every sphere of activity, whether it be political, scientific, commercial, or any other, who have risen from the ranks is one of the outstanding features of American public life. Both candidates for the Presidency in the recent election are examples of this.

Of course, a necessary factor in making such progress from bottom to top possible without danger to the community is the educational system. There can be little doubt that with regard to education of the mass of the people the United States of America is the most enlightened country in the world. This statement is not to be read as implying that the educational system in America is perfect. That would be very far indeed from the truth. Compared with most European systems, however, the English not excepted, there is an immense advance clearly visible. It is possible for anyone who has the necessary mental capacity for the absorption of a high-school education (approximately equivalent to that of our secondary schools) to receive such education. The same is true of a college course, the only difficulty being in many cases the provision of sufficient money to maintain the student during his course. But this difficulty is much less in America than it would be in England because it is regarded as a perfectly natural thing that many college students should, at the same time as they are attending a part-time course, be in employment which enables them to earn enough to maintain themselves. This is so much a recognized part of the scheme of things that many colleges have an employment board by means of which students are helped to find suitable employment during their collegiate period. " Suitable employment " in America is, again, a totally different thing from what would be regarded as " suitable employment " for an undergraduate in England. College students are to be found acting as part-time clerks in business offices, as waiters or " bell-hops " in hotels and restaurants, in various capacities in movie-theatres, or even as distributors of the milk supply in the early hours of the morning. To the American all honest work is honourable, and the fact that a student has to take such jobs as those mentioned in order to keep himself during his college career is regarded as to his credit rather than the reverse.

Among the other striking things which the European notices almost immediately on his arrival in America are, first, the very great difference in the cost of living, and, secondly, the very large proportion of the population which is not American-born. These are, it is clear, bound up with the two outstanding features of American domestic policy as it affects Europe, viz., the protective tariff and the restriction of immigration. The effect of the former is undoubtedly to give money in the United States an altogether different value from that represented by the exchange. In New York the dollar buys, on the average, commodities which could be purchased in London for between two shillings and half a crown. In other cities the purchasing power of money is somewhat higher. Wages and salaries seem generally to be approximately double those prevailing in England, so that the relative position is not very different, and it is only the traveller from Europe to America or vice versa who notices the effect. The relative cost of various commodities is not, however, the same in America as in England. Even allowing for the halved purchasing power of the dollar, clothes are dearer and generally of poorer quality. Railway travelling, however, is cheaper, and so are many of the simpler luxuries of life—those that one may term the " necessary " luxuries—and this makes for a higher general standard of living for all except the very poorest classes. These latter are much less numerous in America than in England, and slums such as those which are still to be found in many English cities are very rare indeed.

The maintenance of this state of affairs is undoubtedly a matter of vast importance to the State, and as such it enters largely into the policies of both Federal and State Governments. There can be no doubt that the restriction of immigration is an essential to the well-being of the nation, both from this point of view and as a safeguard of the national character. It will take at least another generation before the present foreign element of the population can be properly absorbed and made truly " American." There is an astonishingly large number of people in the United States who cannot speak English at all, or only very imperfectly. In one quarter of New York there is said to be a shop which proudly displays the sign " English spoken here."

Such, then, are some of the first impressions which an Englishman receives as he sets foot in America, a land where he is sure to experience a wonderful kindness, unbounded hospitality and a warm-hearted friendliness such as is rarely found elsewhere in the world.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THE EDISON SWAN ELECTRIC CO. LTD., 123/5, QUEEN VICTORIA STREET, LONDON, E.C.4.
L.8.

Some Impressions of Lighting in Birmingham, Manchester, Newcastle and Glasgow

Whilst the special meetings arranged by the Illuminating Engineering Society in the above cities were taking place last year a brief opportunity was presented of examining the conditions of illumination.

During such a short visit it was naturally impossible to get more than a casual glimpse of lighting conditions in these four cities. Yet a few notes on these fleeting impressions may be of interest.

At the first three cities visited we were unfortunate in regard to weather; only in Glasgow was there a clear sky and lingering sunshine when we arrived. The mist and rain at the other three cities doubtless accounts in part for the somewhat sombre appearance of the streets by night, notwithstanding the fact that the public lighting in some of the main streets was undoubtedly exceptionally bright. The writer formed the impression that the surfaces of buildings were apparently darker or less illuminated than in London; certainly the comparative absence of floodlighting, luminous signs and similar supplementary lighting apparatus, which is a familiar feature of the busy amusement and commercial sections of London, was noticeable. There would seem to be opportunities for enterprise in this direction, though admittedly developments in floodlighting are less easy to bring about when trade is bad. Most of the cities in the north have suffered greatly in this respect, though there are now hopes of brighter times in store. Individual cases of floodlighting were, however, to be seen. The white surface of Carliol House, the headquarters of the Newcastle Electricity Supply Co., is thus rendered a conspicuous landmark. It may be added that the interior of the building is equally interesting and well deserves a visit from any members of the Society who have occasion to visit Newcastle.

The lighting of the windows of many shops in leading streets of all four cities was excellent; but there were instances of glare and lamps improperly used.

Several of these cities possess thoroughfares of distinction that deserve the finest form of street lighting. One calls to mind the famous Sauchiehall Street in Glasgow.

By the courtesy of Mr. Anderson, the writer was shown an enterprising exhibit in Birmingham—the model factory which is being equipped in Dale End and furnished with lighting units so disposed as to enable good and bad methods of illumination to be compared. This display, when completed, should prove a useful permanent exhibit.

The writer has left to the last what was perhaps the most interesting piece of lighting witnessed. In other cities time did not permit of a visit to the local universities, but he was fortunate in being able to have a good look at the University of Birmingham, under the guidance of Professor Cramp. Whilst, as might be expected, there is little that is distinctive in the lighting of the older buildings, a new block of buildings devoted to biology and other forms of scientific work has been treated on quite modern lines. The wiring is on the surface. The general lighting is by approved overhead enclosed diffusing units furnishing ample illumination. In each laboratory, moreover, every student is provided with a well-screened local unit, designed according to the nature of the work (e.g. dissecting, microscopy, etc.). The lighting of the lecture theatres bears evidence of careful design. Two alternative systems of general lighting are provided: one for ordinary use the other affording subdued light whilst lantern slides are being shown. Adequate floodlighting is furnished for platform, demonstration table and diagrams; but here again secondary provision is made enabling diagrams or blackboard to be used whilst the lantern is in operation. The lighting arrangements in these new buildings were designed by Professor Cramp, who would no doubt be glad to explain the details to any members of the Society interested. There are no doubt other technical colleges and educational institutions throughout the country with new buildings equipped with modern lighting, and one would like to hear something of the special methods which they have adopted.

Some Attractive Domestic Gas Lighting

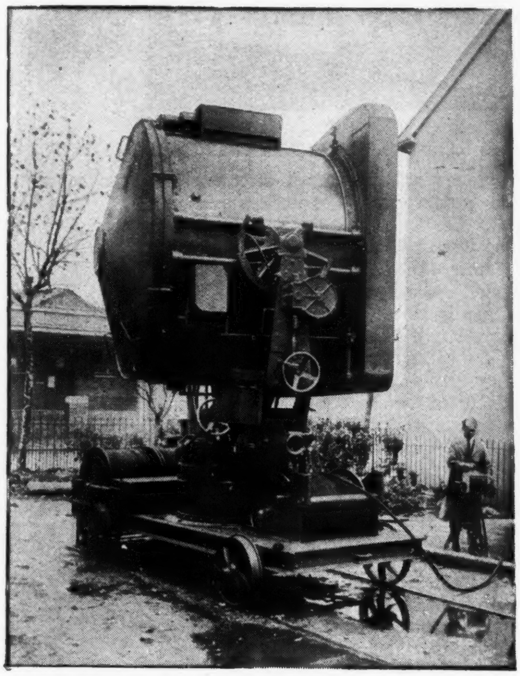
THE photographs reproduced on this page are of interiors in a house which has been equipped recently with modern gas-lighting fittings throughout. The first illustration shows the small dining room, for the lighting of which a pendant of simple design with silk shade has been used. The second illustration shows a portion of the drawing room, in which there is a standard lamp with a beautiful shade, which undoubtedly adds to the charm of the room. This type of lamp is usually connected by flexible tube with rigid screw connection to a convenient gas point near the skirting, a sufficient length of tubing being provided to allow of the lamp being placed in any desired position. It may be mentioned that there is now on the market a "bayonet" fitting for attachment to flexible tubing, by means of which all that has to be done when it is desired to connect the lamp to the gas supply is to insert the bayonet end into a special socket plug fitted on the skirting. The one action not only connects the lamp but turns on the gas. When the bayonet fitting is removed the gas is simultaneously

turned off. The third illustration shows another corner of a room in which a gas candle bracket is used. The bottom illustration is of a combined boudoir and sewing room, lighted by an ordinary bracket with silk shade. Gas-lighting fittings have been greatly improved in appearance during the last few years; no difficulty should be experienced in obtaining fittings which harmonize well with any style of decoration or period of furniture.

Gas-lighting fittings can, of course, be turned on and off by distance lighting switches, which have been on the market for many years. In two hundred cottages and bungalows recently built at Egham at least one room in every house is provided with a pneumatic distance gas-lighting switch, while in some of the houses almost every gas-lighting fitting is turned on and off by switch. These two hundred houses (equipped at the outset with gas fires, gas cooker, gas wash copper, coke boiler and gas lighting) were completed within about a year, at the end of which period every one was sold.

Giant Searchlights

On the occasion of a recent note on a visit to the works of the London Electric Firm, at South Croydon, we referred to the fact that some very large searchlights, stated to be the largest in the world, were in course of



manufacture. An idea of their size may be gathered from the accompanying illustration. The barrels are nearly 7 feet in diameter, and the candle-power of these searchlights, which are being constructed for a Continental power for frontier defence, has been found by tests at the National Physical Laboratory to attain approximately 3,500 million candle-power. A source of this brilliancy should be visible hundreds of miles away, assuming good weather conditions and the absence of any obstruction from the horizon.

These searchlights have other interesting features. They are electrically controlled and arranged for working at elevations up to 90°, so as to be suitable for anti-aircraft work. The operator may be located at a distance from the projector, and yet can control its movements completely by means of the portable controller which he carries with him. The signalling shutter may be worked either from the controller or locally by hand. The searchlight is also fitted with local and hand-control gearing and with a geared pan handle, so that the best possible observation point may be obtained.

Industrial Lighting

A USEFUL HANDBOOK.

In our last issue we referred to the first edition of the handbook on the above subject, issued by Messrs. Benjamin Electric Ltd., as a new departure. The booklet contains 150 pages of condensed information and is assembled in a convenient pocket form. It differs from bulletins usually issued by firms in the lighting industry in the fact that reference to the Company's product is practically confined to Section 8, dealing with lighting equipment and occupying 16 pages. The rest of the publication contains data of a general character. The information is, in the main, naturally familiar to lighting engineers, but commendable efforts have been made to present it in a form intelligible to users of light, and some of the sections show considerable ingenuity in method.

The book contains ten sections. The first two sections deal with fundamental principles and the measurement of light. General principles are explained simply and concisely, and there is a liberal use of illustrations, some of which are new to us; we may mention as special examples the diagrams used to illustrate mean horizontal and mean spherical candle-power and the conception of zones of illumination (Fig. 21). Section 3 (The Economics of Light) explains such matters as the factors underlying cost of light, the influence of improved lighting on production, progress in lamps, etc. (By the way, the choice of a squash racquet court (p. 33) hardly seems the most suitable for a chapter on "economics"!) Section 4, on "How to Test a Lighting Installation," is cleverly worked out. We like the series of "test queries." Section 5, on "The Planning of Lighting Installations," follows fairly familiar lines, but is unusually comprehensive. Reference is made to the familiar tables of intensities, which are reproduced in the final section. We think these tables might now be curtailed somewhat and made more general. Attention may be drawn to a split infinitive ("to properly and economically perform") on p. 70, and elsewhere the phrasing might be improved, though the meaning is almost invariably clear. Section 7 ("How to Improve the Installation") is brief but useful. Section 8 deals with lighting equipment; Section 9 with illumination data and reference tables, and Section 10 contains an adequate index. We are glad to observe that in Section 9 the British Standard Glossary of Terms used in Illumination and Photometry has been adopted.

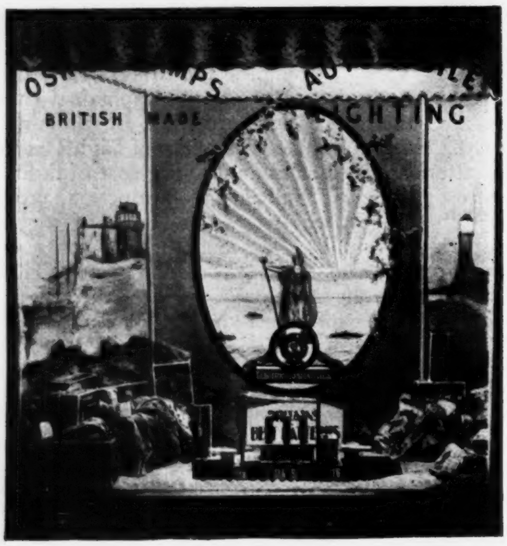
The preparation of this work must have involved a considerable amount of work, and Messrs. Benjamin Electric Ltd. are to be congratulated on an enterprising effort. We understand that there are still a limited number of copies available for interested readers.

INDEX (February, 1929).

TRADE NOTES & ANNOUNCEMENTS

A PRIZE-WINNING DISPLAY WINDOW.

We are indebted to the General Electric Co. Ltd. for the illustration below, which shows the window-lighting display of Messrs. Sympers, Harrow. This display was awarded the first prize in a recent "All England" display competition. The window was illuminated with Osram lamps. We think readers will agree that this is an original and effective display which makes good use of concealed lighting. Much can doubtless be done to improve methods of lighting show windows



The Window Display of Messrs. Sympers, Harrow, awarded First Prize in a recent "All England" Competition.

by competitions of this nature. The fact that this prize was gained by a window situated in a suburban area should act as an encouragement to merchants outside the Central London area, where samples of imperfect window lighting are still too common.

LIGHTING IN INDUSTRY.

This is the title of an attractive booklet issued by the British Thomson-Houston Co. Ltd. The influence of efficient lighting on production is well explained and the essentials of correct lighting are concisely stated. The booklet contains many good photographs showing modern lighting installations. A section on the floodlighting of works' approaches, roadways and railway sidings is of special interest. The central double-page contains a telling display of modern industrial lighting equipment, in which floodlighting projectors now find a place.

CONTRACTS CLOSED.

The following contracts are announced :—

MESSRS. SIEMENS ELECTRIC LAMPS AND SUPPLIES LTD. :—

The Air Ministry; for 12 months' supply of vacuum, gas-filled and carbon-filament lamps.

The Admiralty; for several thousand Siemens vacuum and gasfilled lamps for ship and dockyard use.

The Great Western Railway; for 12 months' supply of gasfilled lamps.

MESSRS. THE GENERAL ELECTRIC CO. LTD. :—

The Air Ministry; for three months' supply of Osram vacuum and gasfilled lamps; also Robertson carbon-filament lamps.

The Great Western Railway; for 12 months' supply of Osram vacuum and gasfilled lamps and Osram vacuum train-lighting lamps.

A ROBUST EXPLOSION-PROOF FITTING.

During recent years much attention has been concentrated on the production of explosion-proof fittings, and Messrs. Heyes & Co. Ltd., of Wigan, have made a speciality of this kind of work. One of their latest efforts, the "Wigan" 100-watt well glass type is here illustrated. As will be seen from the illustration, the lamp fitting consists essentially of two portions, viz., a well glass fitting and a ribbed shaped dome casting, to which is fitted a small circular sealing box. The whole mechanical construction is very robust. This fitting has been subjected to stringent tests by the University of Sheffield. The enclosure itself was filled with the most explosive mixture of fire-damp and air, and this mixture was ignited by a secondary discharge from an induction coil, whilst the apparatus was surrounded by a similar explosive mixture. In a leaflet before us other supplementary tests are described. It is stated that the apparatus sustained no damage, except the cracking of the enamel coating inside the ribbed casting.

We regret that, owing to delays occasioned in the post during the Christmas period, this illustration did not appear in the advertisement of Messrs. Heyes & Co., which appeared in our last issue, p. ix), another illustration being substituted. We therefore gladly take this opportunity of drawing attention to its special design.

RECENT SIEMENS LISTS.

Several lists recently issued by Messrs. Siemens Electric Lamps and Supplies Ltd. illustrate the variety of lighting appliances now available. The latest of these, devoted to show-window lighting equipment and fittings accessories, is illustrated by a number of attractive pictures of windows illuminated by night. The importance of careful design of reflectors is emphasized, and figures are quoted to show the drawing power of illuminations up to 85 foot-candles or more. The standard types of reflectors can be fitted with colour screens, and trough-lighting units and spotlights are also illustrated. In the concluding sections of the catalogue particulars of time switches, thermal flashers, etc., are given.

In passing we may recall that Messrs. Siemens and Electric Lamps and Supplies Ltd. recently moved to larger branch premises at 44A, Westgate, Newcastle-on-Tyne.

ILLUMINATING GLASSWARE.

We have again to record numerous lists illustrating diffusing glassware. Some sheets from the new catalogue of Hailwood & Ackroyd Ltd. contain some very pleasing illustrations of modern types, and the Wholesale Fittings Co. Ltd. have issued a new supplement dealing with "Altolite" glassware, with coloured illustrations of the decorative styles. In contrast to the conventional types, we may also note the new G.E.C. list of "modern style" fittings. In these units glassware is the chief item, but it is assembled in various novel and ingenious forms.